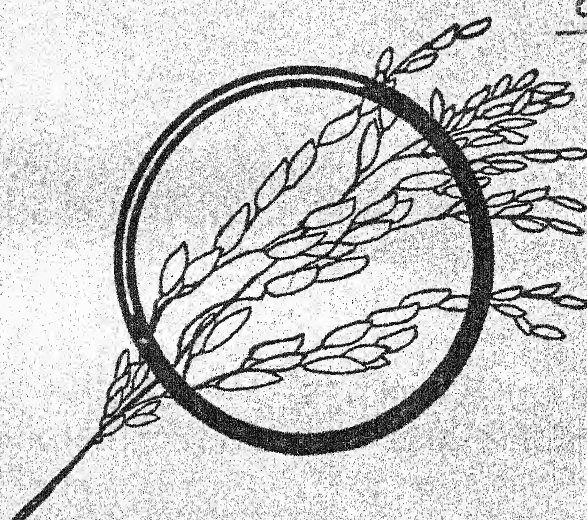
The Agricultural Journal



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PART I

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The Agricultural Journal of India

EDITED BY

The Agricultural Adviser to the Government of India

VOL. XIV

(1919)

PUBLISHED FOR

THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

BY

THACKER, SPINK & CO., CALCUTTA

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VOL. XIV, PART I QUARTERLY *January, 1919*

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THE Journal this month issues with a new cover, for which we are indebted to the artistic skill of Mr. R. Cecil Wood, Principal of the Agricultural College and Research Institute, Coimbatore.

J. MACKENNA,

Agricultural Adviser to the Government of India.

PRINTED BY
THACKER, SPINK AND CO., CALCUTTA.

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P.C., G. C. S. I., G. C. I. E.
Governor of Madras.

Woodhouse-Southern Memorial

Dulce et decorum est pro patria mori

E. J. Woodhouse, M.A., F.L.S.,

Economic Botanist to the Government of Bihar and Orissa.

Born, 15th November, 1884. Died of wounds in France, 18th December, 1917.

* * * * *

Hugh Southern, M.A.,

Deputy Director of Agriculture, Punjab.

Born, 17th January, 1886. Reported missing, April 1916, and officially declared to be dead, July 1918.

The Moon of Peace has risen midst the dark clouds of War and dispelled the gloom which has so long prevailed. But in the case of two members of our department the words of Omar may not inappropriately be applied--

"The Moon of Heav'n is rising once again:
"How oft hereafter rising shall she look
"Through this same Garden after me—in vain!"

Of the members of the department who went forth to fight their country's battles two have made the supreme sacrifice and will not return to us. Woodhouse sleeps his last sleep in the West: the grave of Hugh Southern "no man knoweth."

Now that hostilities are over, I am sure that members of the department and other friends will wish to perpetuate the memory of these young officers. I propose therefore to open a subscription List with a view to establishing in the Lyallpur and Sabour Agricultural Colleges memorial prizes bearing the names of the fallen officers. Personally I favour a general contribution, to be divided equally between the two colleges, but if subscribers prefer, their donations will be allotted to a particular college.

Donations should be forwarded to me at Pusa and will be acknowledged in the Journal.

J. MACKENNA.

Original Articles.

MATERIALS FOR A POLICY OF AGRICULTURAL EDUCATION.

BY

H. M. LEAKE, M.A., F.L.S.,

Economic Botanist to the Government and Principal, Agricultural College, Cawnpore.

Myself when young did eagerly frequent
Doctor and Saint and heard great Argument
About it and about: but evermore
Came out by the same Door as in I went.

In perusing the voluminous literature which has arisen on subjects educational, the quotation which heads this paper comes somewhat forcibly to the mind. I am not oblivious to the retort that this statement obviously raises, namely, why then add to that volume? I have failed to find an answer which satisfies myself, and am fain to admit that it is probably of the same tenor as that to the riddle of our childhood—the riddle I do not remember, but the answer was to the effect that the other donkey did so too. There are certain thoughts, however—perhaps more suitably termed criticisms—which so constantly arise in such perusals that I am tempted to assume the rôle of the other donkey and commence with a few general observations which will lead on to the more special subject of agricultural education.

In all educational institutions we have two factors—the pupil and the teacher; the former, owing to the system of teaching in classes, a multiple, the latter a single, intelligence. This condition too often offers the mental equivalent of a boat's crew. In training

a crew for a race the coach has to think of the crew as a whole and attempt to raise the average physical fitness to the highest point on the day of the race. For this purpose certain members will be over-trained or "stale," others under-trained. The system of training, consisting as it does, or did in my own college days, of combined exercise in the boat, and individual exercise, known technically as swinging, affords a certain amount of latitude in adapting this system to the individual capacities of the oarsmen. Add to this the fact that the rowing age is an age of discretion where the oarsman is capable of interpreting his own feelings and expressing them to the coach, and it becomes clear that the training for a race is a system interpreted by a coach, or teacher, who is aided and checked by the intelligences of the individual members of his crew. The similarity of the conditions of the teacher with his class, to those of the coach with his crew, is sufficiently near to mask the essential and great differences, and this similarity is emphasized by the examination system which fixes a culminating point for the education. For, just as the crew is judged by the result of the race, and as the coach attempts to have his crew in the pink of condition on the day the race is rowed, so the teacher attempts to have his class so mentally equipped on the day of the examination that it will show the best advantage. To do this he, too, adopts a system and, to the extent that the class system, by which the pupils are distributed to him, and the examination system, by which he and his pupils are judged, become standardized, that system also becomes standardized and impersonal.

The force of the comparison, however, lies not so much in the points of similarity as in the differences, and this aspect will repay a brief consideration. The crew is judged by its combined effort which is the resultant of the individual efficiencies of the members of the crew. In the case of the examination, on the other hand, there is no combined effort—the individual efficiencies are not interdependent—and the teacher will be judged differently according as major stress is laid on the average number of passes or on the standard attained by the most intelligent pupils. This difference may be expressed in another way. While the judge at the winning

post of the boat race has no personal influence on the result of the race and, through it, on the coach and the system of training, the judge in the examination, in other words, the examiner, according as he frames his questions and considers the answers to test the general standard of the class or to pick out the best pupils, will have a material influence on the teacher and his system of teaching. Of the former type, the examinations, as conducted in this country, are perhaps the most typical examples, while, of the latter, the scholarship examinations, as conducted at the older English universities, afford a good illustration. The former appear to be the sounder in that it will aim at the maintenance of an average standard of the combined teaching, within the understanding of all the students, about which individual exercises, adapted to the individual intelligences, can be built. The latter type of examination forces the standard of the combined teaching to the level of the highest intelligence—too far above the level of the weaker intellects for any system of individual exercise to be of value.

Again, I have stated the members of the crew have reached an age of discretion. They are in a position to judge by their feelings their physical fitness; they can convey those feelings to the coach who can modify the individual training accordingly. The pupil is in no such enviable position. He is not a judge of his own mental condition and the teacher is, thus, to this extent at a disadvantage, when compared with the coach, that he has to interpret his instruction in terms, not of his own intelligence, but of that of his pupils. This to my mind is a point rarely realized and realized with the utmost difficulty. Again and again I have listened to reasoned and logical arguments on courses of instruction the reason and logic of which, however, appeals to the adult mind, and I have found it impossible to avoid wondering, as I listened, whether the speaker had not assumed in his pupils a mind as logical and as accustomed to reasoning as his own. The danger is, in fact, very real that, in evolving a system which is reasoned and logical, the teacher is evolving one which, by that very fact that it is reasoned and logical, will appeal to the adult and not the pupil mind. He has, in fact, failed in one of the main functions of a teacher, and he

lacks the capacity of projecting himself into the position of the pupil.

There is yet a third difference in the comparison I have drawn. The coach's efforts are concentrated on the race and on turning out his crew on the day in a condition as near physical perfection as possible. It is no concern of his if, on the evening after the race, the stroke dines not wisely but too well, and is later arrested for obstructing the police; nor does he care if another member of the crew spends the rest of the day smoking till he becomes ill. The teacher is in a totally different position with his pupil. He does not, or should not, lose interest in his pupil on the day the examination result is published, though this is perhaps too frequently the case. A teacher who does this is not worthy of the post, and it is only necessary to consider one of the objects of education, and that is, to render the individual a useful citizen, to make this clear. Education has missed one of its main functions if it will not prevent the man who successfully passes the final examination from developing into a pick-pocket.

By the above comparison I have attempted to bring into prominence one aspect of the educational problem, and one which is frequently overlooked, namely, the insignificance of the system compared with the individual. My statement that this aspect is overlooked may be called in question, and it is true that recognition is frequently accorded to the point. I cannot help thinking, on the other hand, that, in this country, as in others, in the distribution of educational finance and in the grants lavished by Government for educational development, which are largely earmarked as non-recurring and are devoted to the erection of new school buildings, too much attention is given to the numbers of schools teaching a standard curriculum, and too little to that improvement of the pay and prospects of the teachers which alone will attract a better class to the profession and thus remove the necessity for that rigid standardization which stultifies the individual initiative—so essential to real education—of the teacher.

The above considerations are of general application; that is, they apply to the educational problems of any country, but from

this point my argument proceeds along two lines, and deals more particularly with the problem as it appears in this country. The first of these deals with the type of education, as influenced by the conditions of the country, the second with the limitations imposed by the system of educational finance.

One of the functions of education has been already stated, namely, to render the individual a useful citizen. That may be a highly materialistic aspect, but the modern world is materialistic, and a country, if it is not to be left behind in the international race, must be materialistic. It is difficult, if not impossible, to find a brief definition which will cover each and every function of education, and the above will, perhaps, serve as well as any for a starting point. Now it is obvious that the world would not be a satisfactory place to live in, if everyone were educated to the clerical profession. The clerk is a useful person, but once the number exceeds that necessary to carry on the essential clerical work, there must be a number of persons who are failing to fulfil that function. It may be that there is here a confusion between education and training, but I think not, though I admit the line of demarcation between the two is not readily drawn. Education then, considered from a national aspect, must be diverse, and, in its practical aspect, consists in placing before the youth of the country the essentials for the development of the mind in a form which will leave the individual in a condition in which he will render useful service as a citizen. In former times the guiding factor in the choice of a profession was mainly parentage, the son following the trade of the father, and this is still very largely the case, especially in more backward countries. But modern thought—the result of compulsory education—is increasingly in favour of equality of chance, irrespective of birth. Within wide limits, therefore, the diversity of education should be so disposed as to place within reach of each individual a form of education suited to his probable future life. A more detailed consideration of the true meaning of this statement is desirable, since it is here, I think, that the fallacy contained in the modern claim for equality of chance, and in the various economic doctrines arising therefrom, is most readily exposed.

In the various professions by which the individual earns a livelihood, the labour expended is rewarded in very different measure in the apportionment of worldly goods, and, with the materialistic aspect of modern life, the professions tend to be judged by this standard and to be desirable in proportion to the measure of these goods received. Equality of chance in practice, therefore, implies a claim on the part of every individual to an education fitting him for the most lucrative profession. Now it is perfectly clear that the world would not be a fit place to live in if every individual were educated for the legal profession. Food and the thousand necessities of modern life have to be produced by human labour, and for that labour the education I have taken, as example, is unsuited. Equality of chance, therefore, is not obtainable by the provision of an education qualifying for the most lucrative fields of employment. The alternative, the equalizing of the reward, while perhaps not theoretically unsound, is practically unattainable. It is only necessary to attempt to picture the economic condition of a country in which the farm labourer receives, say, Rs. 1,000 per mensem,* to understand how far we are from obtaining equality of chance by this means. The fact is, such equality is an ideal, probably undesirable and, certainly, practically unobtainable. Labour of the brain always has been, and will continue to be, more liberally rewarded than labour of the hands, though change may occur in the degree of divergence. Equality of chance is, thus, a fallacy; nevertheless the idea has an underlying basis of truth. That truth is, I think, this. While, for the majority, it is desirable that an education shall be provided which will fit them to fill the station they are most likely to occupy in life, namely, that into which they are born, modern thought demands, and rightly demands, that the individual should not be bound by the accident of birth. Far from this meaning that each individual has a claim to the highest form of education, it implies that a ladder should exist by which individuals in any particular station can ascend, if so fitted, to a

* The same condition will be reached by assuming the High Court Judge to be paid Rs. 7 per mensem, the essential fact being the relation between cost of production and purchasing capacity—that is, relative, and not absolute, values.

higher one. Advancement is, thus, not an inherent right, but the reward of merit. One error running through educational discussions and educational schemes is the misplacement of these two objects of education—the conversion of the ladder provided for the gifted to a broad staircase for the mediocre. The effect of this error is to be seen in most countries, but in none, perhaps, more so than in this. The average individual is led to expect, regardless of economic laws, an education fitting him for a station into which he was not born and, in after life, a remunerative field in that station. The inevitable result is disillusion and discontent, the source of half the social unrest in this and most advancing countries.

I think we have now reached a stage in the argument which will enable us to provide a truer view of educational aim. It is that the main, and major, educational object should be to provide an education which will leave the individual a useful citizen in the sphere in which he was born. The educational ideal, contained in the above, is to inculcate in each individual that habit which is briefly and succinctly given in the catechismal saying, "to learn and labour truly to get my own living and to do my duty in that stage of life into which it shall please God to call me."* It may be argued that that attitude is incompatible with ambition, the desire to ascend, but I think not. That desire may exist alongside the ready acceptance of the fact of failure. But while I insist that this ideal should form the main object of educational policy, I am equally certain that that object will only be completed by the provision of what has been termed a ladder, but a ladder so hedged about that only those suitably equipped may ascend.

If the arguments adduced are sound, it follows that in any country the type of education most commonly found, should be

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* "To do your work honestly, to die when your time comes and go hence with as clean a breast as may be—may these be all yours and ours by God's will. Let us be content with our status, telling the truth as far as may be, filling not a very lofty but a manly and honourable part."

In turning over the pages of Thackeray's "Essays and Reviews" during an idle half hour I have, since this article went to the press, chanced to light on the passage above quoted. It is one which would be hard to equal as a definition of the educational ideal.

adapted to fit individuals for the occupation most commonly practised, and it is only necessary to glance at the figures to appreciate how far education in this country is from the ideal I have outlined.

In the United Provinces "two-thirds of the population are supported by agriculture, and there is no single occupation which supports one-tenth of this number of people." In actual figures these are divisible into the following main classes :—

Zemindars, non-cultivating	500,000
,, cultivating	3,000,000
Tenants with some occupancy rights	10,500,000
,, ,, no occupancy rights	10,250,000
Sub-tenants	2,000,000
Labourers	4,500,000
TOTAL ...	30,750,000

While the latter two roughly constitute a class whose standard of living is such that the children have to begin to take a share in the family labours at a very early age, and for whom, therefore, the simplest primary education is all that can be provided, a very large proportion of the remainder occupy a position, such that the children are not compelled to earn a livelihood till the age of 17 or even later, and for whom it is desirable, both on individual and communistic grounds, to provide an education fulfilling the conditions I have laid down. I have said on individual and communistic grounds—individual, because the world's progress is affecting agriculture equally with other occupations, and that man will succeed best who most clearly appreciates this progress and most quickly profits by new markets opened to him; communistic, because sound development of a community is only obtained by equality in the rate of educational progress of its several component parts, the unsoundest form of development being that where a small minority progresses while the bulk of the population stagnates.

There is thus a large community, probably larger than any other single community of the province, in a position to benefit by a suitable form of agricultural education. This state may be compared with the educational facilities provided, and in doing so care must be taken to distinguish between teaching agriculture, and education

fitting the student to return to the land. The point need hardly be laboured; the literary nature of the mass of the secondary education, unfitting the student for practical work of any nature; the location of the schools in urban surroundings, accustoming the student to a social life he cannot obtain at his home and replacing the healthy out-door life of the individual by the artificial sports of the play-ground—of which, though a true admirer, I recognize the limitations which include a dependence on companions for the supply of his physical recreations—are too well known to require further development. It is true attempts have been made to introduce agriculture into the school curriculum. These, however, come to grief from failure to distinguish between teaching agriculture and supplying an education suiting the pupil to return to the land. It is not realized that the student truly from an agricultural stock knows a great deal about practical agriculture, usually a good deal more than the master provided under such conditions to teach it, and such attempts as have been made hitherto to rectify the educational deficiencies indicated have failed from this cause.

On the first line of my argument, therefore, we have arrived at the conclusion that the present educational system totally fails to satisfy the needs of the largest single element, if not the major portion, of the community. It is true there is an agricultural college, but that is a coping stone without the underlying structure. Moreover, the position of a college will be more clearly understood when the second line of argument has been developed.

Educational effort, like every form of endeavour, is limited by financial considerations. The necessary funds are obtained in a variety of ways. In many cases, as in the older universities and public schools of England, the funds arise from endowments, a system well illustrated by the munificent gifts which have been made for education in the United States. In others, of which the primary educational institutions of England and a large proportion of those of this country are examples, the funds are provided by Government. In the former case the trustees are the sole arbiters in any question as to the disposal of the available funds, and the primary consideration is the degree to which the founders' terms

are complied with. In these cases, there is no question of a financial return, the trust is complete with the fulfilment of the conditions imposed. Where, however, the funds are provided by Government the position is different. Government is merely in the position of trustee for the country, and it is its duty to see that the country receives the fullest measure of return for the expenditure involved. It is no part of my argument to justify the expenditure of public funds on education, that is generally admitted; my concern is with the measure of the return received, with relative, rather than with absolute, values. There can be little doubt of the relative value of the two classes of education; that which, on the average, fits a man for full development in that station in which he lives and has his being, and that which compels him to seek, among fresh fields and pastures new to him, his means of livelihood. The former is a process of gradual evolution of the individual, which allows for development owing to the gradual interaction between the individual and his surroundings; the latter partakes of the nature of thrusting hot glass into cold water, a process ending usually in the destruction of the glass vessel.

The true error in the educational system of this country, as I conceive it, lies in the fact that it has hitherto developed along lines which render it unsuited for the largest single element, if not for the major portion, of the population. This is no complaint that the educational facilities are excessive, but it is a very definite statement that the fullest measure is not being obtained for the funds expended. This is not merely based on negative considerations implying merely a waste of funds, such would be the case if the schools and colleges were filled by the sons of the clerical and learned professions; it implies more than this, the expenditure of funds on directions actively harmful; for, by failing to provide an education fitting the son of the landholder to remain on the land, the system drives such persons into a line of life for which they are unfitted, and in entering which they become as the hot glass to cold water. What is needed, and urgently needed, is the development of a form of education which will leave the average country youth fitted for life in the surroundings in which he is

born; there is ample scope in such surroundings for the educated mind to find full and useful employment and to fulfil the rôle of a useful citizen which we have laid down to be one of the main functions of education.

It is open to argument that I am here labouring to prove a point, the importance of which is already sufficiently recognized. In part that is true; the recent conferences on agricultural education, the first held two years ago at Pusa, and the second last year at Simla, indicate this. The "memorandum showing what has been or is being done to impart agricultural education to the sons of cultivators," published in connection with the report of the last conference, however, shows what a relatively small amount of effort has been devoted to this aspect of education. Nor is my main object to supply this proof. I am tempted to think the difficulty has lain not so much in the recognition of the fact as in the recognition of what constitutes a suitable form of education. The arguments I have hitherto adduced may incidentally prove this point, but that proof is only incidental. Their main advantage lies in the fact that they provide a point of view which will, I think, help to point a way to a solution of some at least of the practical difficulties involved.

I have tried to show that, at least where the funds are provided from public sources, there is a very definite financial limitation to the method of disposal. This will become clearer on considering a concrete case. The Cawnpore Agricultural College has a four years' diploma course limited to 25 students per year, or a total of 100 students in residence. The college budget is Rs. 43,600, but this is clearly an under-charge, as it excludes all charges on the botanical and chemical sides, which are budgetted jointly with research, and it is merely the recurring charge without allowance for interest on capital charges or depreciation on building accounts. It is probable a figure of three-fourths of a lakh is not an over-estimate—that is, a cost of Rs. 750 per annum per student. The question is, under what circumstances is the expenditure of this sum of public money justified? It is always difficult to argue with any degree of conviction as to the justification of expenditure where the return is,

as in this case, indirect. The subject is, therefore, best approached from a different aspect, and there are two such. The first is to discover the circumstances under which that return will be a maximum, and the second to consider the class of applicant now seeking admission.

The justification of the Agricultural Department must be found, in like manner, in the improvement of the economic conditions of the country, and no doubt the expenditure on the college is justified to some extent by the necessity of training members for that department. That, however, is a minor matter, two only, out of the 25 students annually admitted, being admitted to the service. Were that the only object of the college, it would appear possible to find a more economical method of recruitment. The truth is that the ultimate justification must be found in the future career of the 23 remaining students.

Now, considered in a relative aspect, it cannot be doubted that a single zemindar, possessor of several villages, who takes a personal interest in his estate and who is progressive, by reason of a liberal education such as the college is now in a position to give, is potentially a far greater asset to the country than the small zemindar or tenant cultivating a few *bighas*. In the former case the gain is not limited to the actual money value of the better crops produced, and of the extra gain due to better business methods, great though this may be. His property forms a practical demonstration which must have some influence on the surrounding countryside, and he himself becomes an unpaid propagandist of new methods. The latter, on the contrary, can do little more than grow better and more valuable crops, and he possesses little of that which we may briefly sum up as influence. The college will be filling its function to the full, therefore, only when the main source of recruitment is the zemindar class, a class relatively small, perhaps, but numerically large and potentially powerful. It can hardly be doubted that a college with students so recruited would be in a position to do more to improve agriculture and the economic conditions of the countryside, on which that improvement so largely depends, than one with students recruited from any other source. It is

the condition in which the college will most fully justify its existence.

That, at least, is the aim I have set before myself since I have been in charge of the college at Cawnpore. It is, for many reasons, an aim not immediately realizable. The larger landholders are mostly non-resident and have more immediate interests. The smaller ones are shy and frequently insufficiently educated. For the present it is sufficient if a few only of this class come, and it is a hopeful sign that this is the case.

The majority of applicants at the present time are, nevertheless, men merely seeking Government appointment intermixed with true agriculturists, petty zemindars or tenants. Frequently the application is accompanied by an appeal for a stipend. With the former I have no concern, they are not the type of student for whom there is any opening. The latter, however, form the class to which the department looks for its recruits and the admission of a few is justified on this ground. The claim for a stipend is a different matter, and as it is here that the financial aspect receives its clearest demonstration a short digression will not be amiss.

To any one who has had to deal with the selection of students for admission to a college the frequency with which poverty, as a ground for admission accompanied by financial assistance, is advanced will be well known. The fallacy of such a claim has, as far as I am aware, never been shown up; it is certainly not generally recognized. What applies for one applies to all. Were poverty to constitute in one case a claim to admission to a college with a stipend, every youth of suitable age would be justified in demanding this concession, and the collegiate education would become the standard the State is called upon to provide. The cost, placed at Rs. 750 per annum in the case of the college, to the State is clearly prohibitive, and those persons who advance such a claim forget that the money to provide the education and stipends ultimately comes from their own pockets. The fact is that stipends are only justified in cases where poverty appears as a check to an ability, to the possessor of which a college course will open a useful and profitable career.

I have now attempted to define, by reference to the Cawnpore College, the legitimate function of such an institution. That function is, to a certain extent, based on local conditions, and is not, therefore, necessarily identical with that of other colleges. The same financial consideration, however, underlies all, and the college aspect can never do more than touch on the fringe of the problem, reaching as it does only the numerically smallest class of persons connected with the land. If the true function is performed, however, the college will be the means of providing, in the departmental district officers and in the progressive zemindar, two agencies of effective agricultural development. The speed of introduction of improved methods is, however, a reciprocal process dependent not only on the skill and energy of the instructor, but on the receptivity of the instructed. While, therefore, the college is providing for the former, the latter is in no way provided for. The form of education provided is too expensive for the mass, it is moreover collegiate.* What is here required is a cheap form of secondary education, complete in itself and complete within the limits provided by the age at which the average boy leaves school. In the United Provinces the sole attempt hitherto to provide an education of this type is in the vernacular two years' course of the college. The institution of this course and its location at the college is admittedly a temporary arrangement and the course suffers from many disadvantages. In the first place, the age of admission is too high for a true secondary school, being the same as for the four years' diploma, or collegiate, course. Secondly, in addition to supplying a course of instruction suited for the class which we are now considering, it attempts to meet the needs of the members of that class which I have shown the college should attract, but those members who possess insufficient knowledge of English to take that course, two aims which are incompatible. While, therefore, the course has not been without its uses, it fails in several directions to meet the needs of the situation. In other provinces greatest progress in attempts

* Or should be. Owing to the weakness of the secondary education, the teaching has to make up the deficiency and is largely secondary in character.

to solve the problem has, perhaps, been made in the Bombay Presidency where several vernacular agricultural schools are in existence. The cost of each pupil is stated to be Rs. 180 per annum, grounds which alone would place it beyond consideration for universal adoption.* The main problem, the provision of schools supplying an education fitted to the needs of the mass of the agricultural population and at a cost which makes possible their establishment in numbers sufficient for the accommodation of the available pupils, still awaits solution.

The primary object of such schools will be to raise the receptivity of the younger generation of agriculturists and the method of attainment must be through education under conditions which retain the association with the land. This is a very different proposition to the provision of vocational schools, of which the main function is to impart technical skill. In the latter, technical instruction is the primary consideration, and theory is only taught in so far as it bears on the particular trade. In the former, it is true, subjects bearing on the vocation may, and do, form part of the course, but the centre of gravity of the instruction is shifted. These subjects are taught for their internal value as a means of education, and the practical application is left to be drawn by a process of natural imbibition in the daily life. It is here, as I think, that the efforts which have been made to introduce agriculture into the existing schools have failed.

Let us consider for a moment how an agricultural school of this type would be organized. The courses of instruction are to be educational and the students are to be introduced to an appreciation of a standard of country life, something superior to the ordinary village life they have known, by a process of familiarity. Although, therefore, not directly a part of the education, the conditions and their arrangement will form as, if not a more important section of the school organization than the purely educational section, in that they will form an essential of all such institutions, while modification

* A boarding secondary school of the present type costs approximately Rs. 60 per annum for each pupil.

to suit the different grades of schools will be made in the educational courses.

I will try and bring out the main features of such an organization by a description of such a school as I conceive it. It is to offer a practical demonstration of village life under improved conditions, under which the student will live and have his being with a degree of intimacy that will render those conditions a normal part of his existence. Now the essence of village life is the family, living as a unit cultivating a certain area—greater or less according, in part, to the circumstances of the family, but, in part, also, according to the locality. Thus the holdings in the east are, on the average, much smaller than those in the west of the provinces, and allowance will have to be made for such divergencies. The school will now represent a village, the unit of communal life, composed of families, the unit of private life. Assuming a middle school with a five years' course and the maximum age 17 or 18, the students of the senior class will each represent the heads of the families which will be made up of, roughly, one student from each year, giving in all five members to each family. The school will have approximately sufficient land to provide for each "family" of five students an area, roughly, equal to the average holding of the locality. In this community the headmaster and his assistants will play the rôle of the zemindar and his agents. He will apportion the farm lands among the "families," issuing yearly leases at reasonable rents, and the "family" will then cultivate the land under his directions, actually performing the operations themselves. The next year a rearrangement of students in the "family" necessitated by the head leaving and by the introduction of new admissions, combined with a redistribution of leases, will give ample opportunity for arranging that each student will obtain practical experience, during his period of residence of each of the crops cultivated.

Before passing to the strictly educational aspect of the course, we may consider this proposal in some further detail. I have said the headmaster will play the rôle of zemindar; he will, if the scheme is to attain its full development, have to play many parts. As zemindar, I have stated, he will issue leases at reasonable rents,

It is not proposed that these rents should necessarily be paid. The headmaster should also organize the school as a co-operative society, of which the individual heads of families are members and from which the rent can be advanced. Reality can be given by the payment of a nominal sum by each "head" for membership, but the rent and most other transactions, being dues to the headmaster, may be book entries merely. Produce would be similarly pooled for disposal on co-operative principles and may even be used to supply a co-operative store to supply the necessaries of life of the students. If payment be actually made by each student or by each "head," a nominal bonus may be given, otherwise the transactions will, throughout, be nominal as regards cash values, but in all respects should conform with reality. Thus, the amount shown to the credit of a "family" for produce received should be based on the actual sum for which the produce was disposed.

The above constitutes what I may term the environmental aspect of the school; the educational aspect may now be considered. This is an aspect which, more than any other, suffers from the danger of dogma, and, in the present case, it in no way differs from the general problem as it appears in all educational institutions. It is a problem to which each individual will offer a different solution depending on his particular personal bent. Such solution as I shall offer is, therefore, of necessity so coloured. Education as found in this country fails in two directions—the first, practicality; the second, accuracy. With the former I have already dealt; the whole organization of the environment is aimed at developing this character. The latter must be developed in the class-room. For this purpose the following subjects seem best fitted: mathematics, associated with which may be book-keeping and accounts, and elementary physics. With these subjects emphasized, the remainder of the course will be composed of those subjects which form the basis of the curriculum of the ordinary school, preference being given to subjects which have some association with the life the students lead. Care, however, must be taken to teach each as a balanced subject without undue prominence given to their supposed practical aspects. Among such subjects I should place English, geography,

physiography and elementary studies of plant life. In the above course—and it is not desirable to go into greater detail at present—my main object being to develop principles rather than detailed schemes, the only direct point of contact between the environmental and educational sides of the school lies in the accounts, for which the books of the institution may well be used to provide practical examples. A comparison of this outline with, for instance, the curriculum of the Loni School, will bring into prominence the difference I have tried to emphasize.

A pupil taking five years to pass through such a course would thus gradually imbibe the practical aspect of agriculture; would be gradually introduced to those conditions which tend to place the cultivator in a position of sturdy independence and self-reliance, and should, by the end of his school career, be fitted to return to his home and the reality of life with a sense educated to realize the more backward conditions and a will to remedy them—a condition of mind and body suggestive of a career as a useful citizen. The information will, moreover, be learnt by a process of absorption from constant association, one of the essential conditions if the soundness of my contention is admitted.

There remains the question of cost, the question whether the scheme will satisfy the second or financial consideration, which it must do if it is to justify the expenditure of public funds involved. With 30 students in each class, a school of 150 will be formed for which an area of 150 acres' cultivation will be required if each holding is calculated at 5 acres. As most of the labour will be provided by the students, the labour bill will be small and the profit on cost of production should be considerable. In addition, there will be the capital charges and the cost of instructional staff. The former will be larger, but the latter not necessarily greater than the same charges of a school of the same standing but of the usual type. The unknown factors at the present stage are too numerous to make it possible to draw up a balance sheet which would approach any degree of probability to the actual, but it seems more than probable that the cost would be, on the balance, low. One point at any rate is clear; unless the farm is working at a profit, and a handsome

profit, it will not be fulfilling its function, and we have here, therefore, a very simple and practical test.

One point remains to be considered, and it arises from what I have said early in this article, in bringing out the difference between the coach and the teacher. However good the system is, it will never succeed in producing the desired result unless the agent, in this case the teacher, is competent to develop its potentialities. The aspect requires no enlargement, as its essential nature appears to be fully recognized and formed the subject of much discussion at the Simla Conference. For the present purpose it is sufficient to point out that the supply must be derived from the Agricultural College and forms a third legitimate field, additional to the two already described, of activity for the college.

The proposals outlined above constitute a scheme for providing for the educational needs of the largest section of the community, and, as far as considered, suffices for the main educational function, to fit the average youth for a useful and contented life in the conditions under which he was born. There remains the second aspect, without which no educational system can be considered complete, that of providing a ladder by which those intellectually qualified can arise. If such a ladder is to be provided, it follows that a system of secondary schools leading to the University or to the Agricultural College must be introduced. On this subject the Simla Conference showed considerable diversity of opinion, and the probability is that the exact direction in which this will develop cannot be forecasted with any degree of certainty, and will depend on the exact form of school that is found to succeed. I will content myself with noting a single point. The type of school I have outlined contemplates the performance of the field-work by the pupils, each holding possessing a body of pupil labourers of decreasing age. If such a scheme is to succeed, and the practical work is to be carried out with that efficiency which will alone ensure success, the oldest pupils must have attained a physical development enabling them to do the more arduous field labour. That consideration would seem to indicate that greatest efficiency will be developed in those schools where the age limit is relatively high, and hence that the type is

best adapted to schools of the secondary class. The absence of the necessary physical power in the students of the Loni School was one of the points that struck me most forcibly in the one visit I was privileged to make to that school. It would appear possible that schools of this type would lead directly to the college, and that the ladder we desire would be provided in this manner. The truth is that the practical difficulties, not the least of which is the absence of teachers, are such that the development of such schools must be slow and will afford ample opportunity for gaining practical experience. It is not desirable, therefore, at the present time to enter in too great detail into such matters. It is essentially a case for trial and experiment, the establishment of a few schools of the type described and their gradual extension in that direction which experience shows to be most desirable. What is essential is a clear comprehension of the fundamental principles which underlie the problem—a comprehension so sharp that it can be used as a test during each stage in the experiment. To the best of my ability I have attempted to supply the materials for such a test.

PRESENT POSITION AND FUTURE PROSPECTS OF THE NATURAL INDIGO INDUSTRY.

IV. THE EFFECT OF SUPERPHOSPHATE MANURING ON THE YIELD AND QUALITY OF THE INDIGO PLANT.

BY

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In a preceding article[1] I pointed out that owing to the rapid impoverishment of the Bihar indigo soils during recent years the position of the indigo industry has become very critical. When the Java variety of plant was first introduced into Bihar extraordinarily high yields of indigo were obtained—sometimes as much as 30 to 40 seers of 60 per cent. indigo per acre—but after two or three years the yield of indigo began rapidly to decline. The mysterious disease "wilt" appeared in 1907, characterized by the partial or complete loss of the *khoonties* or second cuttings and failure of seed crops. In my last article I showed that the failure of crops was progressive, becoming more and more marked each year until, in some cases, the yield of indigo was reduced by nearly two-thirds. Not only was there an increasing failure each year of khoonties, but the *moorhan* crop became of inferior quality and yielded less produce. In the years immediately preceding the war, as indigo became a less and less paying crop, the area under indigo was greatly reduced, and this to some extent relieved the situation by giving the soils a chance to recover, but the greatly increased growth of indigo which followed the outbreak of war in 1914 and

[1] *The Agric. Jour. of India,* vol. XIII, page 441. (*Indigo Publication* No. 2.)

its continuous cultivation during the past four years has again created a critical situation.

A year ago, from a detailed study of the indigo soils of Bihar,[1] I concluded that "*unless superphosphate manuring is generally adopted, an enormous falling off in the output of natural indigo will occur during the next few years,*" just at the time when it is essential that produce should be at a maximum in order successfully to compete with the synthetic. This prophecy, I regret to say, has been realized this season at most factories. From reports which have been sent to me of the results of this season's moorhan mahai, *in many cases the produce obtained has only been about one-half that obtained in the corresponding mahai last year. Even where there has been a fair yield of actual green plant per acre, very little dye could be extracted from it.* In several cases the produce per acre has been less than 5 seers of cake indigo from Java plant, which, compared with the yields of 30 to 40 seers which were obtained in the early days of the introduction of this plant in Bihar, is lamentably small. As one planter has put it, "*The produce this year as well as the crop have been the worst on record.*"[2] In my last article I emphasized[3] that in the year 1917-18 the average yield of indigo per acre in Bihar fell off by nearly 20 per cent. as compared with 1916-17; this year, as I feared, the yield per acre will be far less than in 1917-18.

There is no doubt that the climatic conditions this year have been very unusual, and a series of analyses made of the growing plant, which will be published later, shows that the indican content of the leaf has been unusually low. But that the principal factor in determining high yields of indigo (not merely of green plant per acre, but the produce from it) lies in the nature of the available

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[1] *Indigo Publication* No. 1, page 66.

[2] In this particular case the actual indigo obtained was of far lower *quality* than that made last year. Whereas last year the indigo made at this factory was very high grade, a large proportion containing more than 70 per cent. of indigotin, seven samples out of the fifteen analysed by me this year contained less than 55 per cent., and only two samples contained more than 60 per cent. It is very significant that *all* the best dates were from Sumatrana indigo and *all* the worst (in these the indigotin was less than 50 per cent.) were from Java indigo.

[3] *The Agricultural Journal of India*, vol. XIII, pt. II, page 451. (*Indigo Publication* No. 2, page 10.)

foodstuff *in the soil* at the time the plant is grown appears clear from the results which will now be recorded.

THE EFFECT OF SUPERPHOSPHATE MANURING ON THE YIELD OF INDIGO PLANT PER ACRE AND ITS RICHNESS IN INDICAN.

During the past season only a very few planters made trials with superphosphate manuring on their estates. But where such experiments were made the results were very favourable and fully confirm the view I have so frequently expressed that the depletion of available phosphate in the soil has been the principal cause of the failure of indigo crops in Bihar of recent years, and that by proper manuring it will be possible again to obtain the high yields of indigo which were given by the Java plant when first introduced into Bihar. The following cases may be quoted:—

(1) Mr. L. W. Lydiard of Nawada, Champaran, reported on 6th June, 1918:—

"I sowed 4 acres of Java in lines for a seed crop in the first week of August (1917) and put in super a week before sowing. I got about 4 maunds an acre of seed* and cut the crop down at the end of March and have now *splendid* khoonties in the 4 acres, which I shall be cutting next week, 3 feet high. I also 'supered' 5 acres of general crop Java, putting down the super at 2 maunds an acre, middle of September; sowed *gram* and Java ten days later and got a very heavy Hatthia rain on it. Thirteen acres were sown at the same time (that is 8 acres without super, 5 with). **The gram crop was good in the five acres with super and a failure in the eight acres. The indigo is magnificent in the five acres and wretched in the eight acres.** The lands are of one and the same sort and last year *all of it gave a poor crop.* I am getting three or four times the quantity of super this year. If only

* This is an unusually good yield at the present time. Most estates yield no seed at all or only about 1 maund per acre.

super were available at pre-war rates, I should put it in all my *zerat* lands."

(2) Mr. A. W. Fremantle reported on 12th July, 1918 :—

"I tried superphosphate to a small extent last season—*the one acre (with super) gave 12 carts per acre moorhan as compared with the acre next to it which gave 6.* The rest is in *makai* (maize) and *bhadai dhan* (rice) land and the increase remains to be seen."

(3) Mr. E. Moore of Barah, Champaran, reported, on 9th April, 1918, the results obtained by growing Java indigo for seed, in one case with superphosphate only, in the other with cow-dung as manure. The details are as follows :—

(*a*) *With super* : Barra Dih Zerat. Two bighas. Super applied $1\frac{1}{2}$ maunds per bigha, July 19th, 1917. Indigo sown August 6th. Total yield of indigo seed = 6 maunds 35 seers, that is *3 maunds 17½ seers per bigha.* The plant was only slightly diseased and grew to the height of about 4 feet.

(*b*) *With cow-dung only* : Mohowahwara Zerat. Eight bighas. Manured with cow-dung, and indigo sown for seed crop on 18th July. Total yield of seed from the 8 bighas = 6 maunds 15 seers (*that is only 32 seers per bigha*). The plant was badly diseased and about 3 feet high.

It is clear from these results that manuring with cow-dung alone is not sufficient to ensure a good crop of indigo seed under present conditions of the soil.

(4) Mr. F. B. Robinson of Sagrampur, Bhagalpur, writes (23rd August, 1918) : "I experimented with this manure (superphosphate) this year and with lime, having 12 plots each of $\frac{1}{10}$th acre. *The plots (two in number) which had super in them were the only ones that yielded any sort of crop of indigo.*" In a later letter Mr. Robinson writes (15th September) : "The effect of superphosphate was wonderful, and I shall manure several acres this year." Mr. Robinson gives the following summary of

the results obtained on the small experimental plots (each $\frac{1}{10}$th acre in area).

Manure on plot	Produce	REMARKS
5½ seers super	5¼ bundles plant	Plant 3 feet high and very leafy
5 seers super	5 ,, ,,	Ditto
17 mds. lime per bigha	1 bundle ,,	About 1 foot high, hardly any leaf
8½ mds. lime per bigha	1 ,, ,,	Ditto
No manure	1 ,, ,,	Ditto

The analyses of the Sagrampur soils are given in *Indigo Publication* No. 1. They differ very strikingly from most of the Tirhut soils in being very deficient in lime as well as in phosphate. Manuring with superphosphate at the rate of 1¼ mds. per acre increased the yield of indigo five-fold, whereas the addition of lime alone gave no increase of crop.

(5) The most striking results with indigo, however, were obtained by Mr. G. Moore of Moniara, Saran.* On June 5, Mr. Moore reported:—"As regards superphosphate, after green-manuring with *sannai* I applied super and I am pleased to tell you the lands treated *thus have a splendid crop of Java and it was poor land. I also kept* a *chakla fallow, of good quality*: *the Java on this is not so good as the other.*"

* Mr. H. L. Russell of Suddowah, Saran, has reported the effect of superphosphate on oats during the past season (5th June, 1918): "Just a line to tell you that on the few bighas of oats where I put down superphosphate my outturn was 7½ maunds per bigha. My total outturn on the rest of the lands was 4¾ maunds the bigha." It should be noted that owing to the failure of rains in the cold weather of 1917-18, the yield of oats throughout Bihar has been exceptionally poor. Colonel V. N. Hickley (3rd May, 1918) has sent me the following details with regard to the effect of super-manuring on the oat crop at Ottur.

		Average return of oats per bigha	
		Maunds	Seers
Season 1915-1916	.. No seet but 2 maunds super per bigha	12	21
,, 1916-1917	.. ,, ,, ,,	11	3
,, 1917-1918	.. No super, no seet	5	1

As already stated the oat crop was poor in Bihar this year owing to lack of winter rains, and Colonel Hickley states that "in a normal season the outturn without super should have been 8 maunds per bigha."

At my request Mr. Moore made arrangements separately to mahai the indigo grown on the land manured with super and sannai, so as to compare the produce obtained from such plant with that grown on the same estate and at the same time under other conditions of treatment. On July 17, Mr. Moore sent me the results given in Table I (pp. 40-41). On this date he reported :—"I had very fine Java plant this year, but the *best crop was on the land green-manured and treated with super afterwards—not very high, between 5 and 6 feet, but covered with leaf.*" On August 23, he wrote :—"Khoonties I am sorry to say were a wash-out this year. *What there are though are on the super-treated lands which is satisfactory.*" Mr. Moore's results are particularly valuable in showing the enormous effect of proper manurial treatment on the *quality* of the indigo plant—that is, its richness in indican and the "produce" it yields. As this side of the question has hitherto been largely overlooked, although of supreme importance, it is desirable here to consider the results in some detail from this point of view.

The effect of manurial treatment on the quality of the indigo plant.

The following Table (II) abstracted from the data in Table I shows the yield of green plant per acre, the weight of cake indigo obtained per acre, the yield of cake indigo per 100 maunds of green plant, and the weight of green plant required to produce one maund of cake indigo under different conditions of manurial treatment.

TABLE II.

Yields of indigo from Java plant at Moniara under different manurial conditions.

Date of mahai	Treatment of land	Acres cut	Average yield of plant per acre		Average yield of cake indigo per acre		Quality of plant: Yield of cake indigo per 100 mds. plant		Quality of plant: Green plant required to produce 1 md. indigo		Remarks
			Mds.	Srs.	Srs.	Ch.	Srs.	Ch.	Mds.	Srs.	
June 17	Kept fallow 12 months ...	10·47	95	12	10	5	10	14	368	0	This land was of better quality than that treated with super and sannai
" 18	Super and sannai	9·60	94	6	13	2	**13**	**15**	**284**	**20**	Steeping with very cold water (83°F.)
" 19	Jamoona Singh's *khuski* ...	2·40	208	20	16	12	8	0	497	15	Java grew to tremendous height in these two fields—8 feet—but more wood than leaf
" 22	Manured with seet water ...	3·05	218	28	14	12	6	11	593	0	
July 4	Super and sannai	4·01	**153**	**1**	**32**	**4**	**21**	**1**	**189**	**20**	Height of crop 5 to 6 feet. Covered with leaf from top to bottom
" 5	Seet dug in with *kodali* ...	8·29	79	34	12	10	15	13	252	10	
" 6	Seeted land sown in February, along with Sumatrana	7·85	119	32	16	15	14	2	282	10	
" 7	Seet dug in with *kodali* ...	13·09	84	11	11	7	13	10	233	0	
" 8	Java of Bhoji Chaper mixed with February sowing	10·04	88	23	13	3	14	15	267	10	
" 9	February sowing of Java ...	13·83	72	24	6	5	8	11	458	20	
" 10	February sowing and Hiranda plant	12·22	78	4	11	2	14	4	279	20	

The following points stand out very clearly as regards the effect of conditions of growth on the *quality* and yield of produce :—

(*a*) In the early June cuttings, a fortnight after the break of the rains, the *quality* of the plant grown on super and sannai was far higher than that grown under other conditions, as shown by the highest yield of cake indigo per 100 maunds of plant* (*viz.*, 13 seers 15 chataks). But at this stage the plant grown on super and sannai was not fully developed and the yield of green plant per acre was lowest (94 maunds per acre). There was an enormous growth of plant on the *khuski* land and on the land manured with seet-water, but although the plant was very tall it was of poor quality and contained little leaf.† The consequence is that the yield of cake indigo per 100 maunds of plant was very small (8 seers 0 chatak and 6 seers 11 chataks in these two cases). On the land manured with seet-water there was a rapid *forced* growth of indigo, and the plant grew to a great height (8 feet), but there was very little indigo in the plant. The consequence was that it took 593 maunds of green plant to produce 1 maund of indigo as against 284 maunds of the *rich* plant grown on super and sannai.

The plant grown on super and sannai was very much better in *quality* than plant grown on *better* land which had not been treated with manure, but left fallow for 12 months—as shown by the yield per 100 maunds of plant being 13 seers 15 chataks as against 10 seers 14 chataks. Thus although the actual yield of *plant* per acre was slightly less (94 maunds 6 chataks as

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* On the day this plant was worked the conditions were, too, most unfavourable for a good steeping, the water being exceptionally cold (83°F. instead of the customary 90°F.).

† The growth on these lands was forced by the high proportion of nitrogenous food in the soil. It grew to a great height (8 ft.) but the lower leaf was rapidly shed in consequence of unbalanced growth. As a result the plant in June largely consisted of stick and it gave a very poor yield of indigo. On the other hand, the plant grown on super and sannai although fairly tall was covered with leaf from top to bottom.

against 95 maunds 12 chataks), the actual produce of indigo *per acre* was considerably higher (13 seers 2 chataks as against 10 seers 5 chataks).

On June 18th, however, the plant grown on super had clearly not reached maturity and was not really ready for cutting. This is shown by the greatly increased yields obtained when the same plant was cut a fortnight later (July 4). Consequently at the earlier stage (June 18) the yield *per acre* (13 seers 2 chataks) was somewhat less than in the case of the khuski crop and the land manured with seet-water (yields 16 seers 12 chataks and 14 seers 12 chataks per acre, respectively) where there was an enormous, *rapidly grown crop* of poor quality.

(*b*) In the interval between June 18th and July 4th, there was heavy rain (15 inches) followed by a dry spell between June 27th and July 4th. In this period the plant grown on super and sannai developed considerably—the yield *per acre* increased about 60 per cent. (from 94 maunds 6 seers to 153 maunds 1 seer), whilst the *quality*, judged by the yield of indigo per 100 maunds of plant, was increased also to the same extent (from 13 seers 15 chataks per 100 maunds of plant to 21 seers 1 chatak). By the first week of July not only **was the actual yield of green plant per acre far higher in the case of the super-treated land, but the quality was also far superior, so that the yield of cake indigo per acre reached the phenomenal value of 32 seers 4 chataks per acre for a single cutting.**

This value is from 2 to 3 times that obtained from plant grown on the seeted land and mahaied at practically the same time (July 5th, July 6th and July 7th).

(*c*) The figures given for the average yield of cake indigo per acre *dispose of the view frequently taken by planters that the low yields of indigo recently obtained on most estates are due to deterioration of the Java indigo plant.* It is clear

that when the soil conditions are favourable (and these favourable conditions can, I consider, be largely assured by proper manuring) enormous yields of indigo can be obtained even in a year of unfavourable climatic conditions and with the existing Java plant. The yields per acre of 153 maunds of green plant and 32 seers of cake indigo for a single (moorhan) cutting far exceed the yields obtained from the Java plant in its palmiest days—shortly after its introduction into Bihar. Thus in the case of the extraordinary yield of $41\frac{1}{2}$ seers of cake indigo per acre obtained at Bhagwanpur[1] in 1906-1907, this was made up of *three* cuttings, which gave respectively 14 seers 9 chataks, 17 seers $4\frac{1}{2}$ chataks, and 9 seers 12 chataks. Such a yield as 32 seers of cake indigo from a single moorhan cutting is, I believe, almost without precedent. The actual yield obtained at Moniara on land treated with super and sannai far exceeded my most sanguine expectations of what could be accomplished in a single season by proper manurial treatment. It cannot of course be expected that *all* lands will respond at once in the same marked way to manurial treatment, but it appears to me certain that the majority of lands in Bihar can, by steady manuring for a few years, be made to yield 20 to 30 seers of indigo per acre *in the course of the two mahais*. This result will be attained not merely by increasing the yield of green plant per acre, but largely by improving its quality, that is by allowing the plant to grow under conditions which bring about a maximum content of indican in the leaf.

It is not sufficient merely to obtain a rapid and abundant growth of green plant. Such a growth may be obtained by manuring with seet or seet-water, or other

[1] *The Agricultural Journal of India*, vol. XIII, pt. III, p. 446. (*Indigo Publication* No. 2, p. 6.)

nitrogenous manures, such as cattle manure or oilcake. But the general experience of planters is that plant grown under such conditions has "nothing in it," and fails to yield good produce. This view is confirmed by the results in Table II obtained on June 19th and 22nd, where there was a phenomenally large growth of plant in two fields (208 and 218 maunds per acre for the first cutting) but the produce per 100 maunds of plant was very low (8 seers and 6 seers respectively).*

From the results at Moniara it would appear that a combination of green-manuring with sannai and superphosphate is an ideal one to ensure not only a high yield of plant, but also high quality. Whether this is so in general can only be decided by actual trials on the large scale. Unfortunately at Moniara no trials were made for comparison with superphosphate alone. There is the danger that abundant green-manuring with sannai may encourage rapid and forced growth of plant at the expense of quality. That this was *not* the case at Moniara, and that the nitrogenous constituents of the sannai only came slowly into action without forcing growth, is shown by the fact that on June 18th the yield of green plant per acre (94 maunds 6 seers) was only the same as on the fallow land (95 maunds 12 seers), whereas on the seeted and khuski land the yield of green plant at the same date was double as great (218 and 208 maunds respectively). But in the fortnight from June 18th to July 4th, the plant grown on the land treated with super and sannai, grew rapidly and also improved enormously in *quality*. The final plant obtained, however, was never so tall as on the seeted lands in

* Compare also Rawson's data (Report, page 13)—By manuring with seet (5 tons per acre) the yield of plant *per acre* was nearly doubled, but the produce per 100 maunds of plant halved, so that the yield of dye remained practically the same as on unmanured land.

June—it only reached a height of 5 to 6 feet as compared with 8 feet on the seeted lands—but *it was covered with leaf from top to bottom, and the leaf was obviously very rich in indican.*

(*d*) Some planters seem inclined to attribute the abnormally low produce obtained this season—a result which last year I foretold would occur—to abnormal climatic conditions, rather than to the real cause, which I consider is the exhaustion of the soil of its available phosphate supply. That the climatic conditions have been abnormal is very true—a very early break of the monsoon (June 1st) followed by an interval of 10 days without rain, then a heavy downpour on June 23rd and 24th again followed by a 10 days' break. Between July 5th and 11th, 8·39 inches fell at Pusa, and then there was another prolonged break from the 16th to 26th with heavy showers from July 27th to August 1st. From August 2nd to 5th no rain fell, but the 6 days from August 6th to August 11th were very wet with 14·00 inches of rain.

But the fact that even in this abnormal season,* on the land manured with super and sannai at Moniara, such

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* There was practically no winter rainfall in 1917-18. At Pusa up to June 1st, the rainfall was 4·47″.

From June 1st to June 5th	2·48″
,, ,, 6th to ,, 8th	2·90″
,, ,, 9th to ,, 11th	0·70″
,, ,, 12th to ,, 22nd	0·74″
(A break of 10 days in which only slight showers occurred on 8 days.)	
From June 23rd to June 24th	4·61″
,, ,, 25th to July 4th (break of 10 days)	0·07″
,, July 5th to July 7th	0·84″
On ,, 8th	5·16″
From ,, 9th to 11th	2·39″
On ,, 12th	0·00″
From ,, 13th to 15th	1·52″
,, ,, 16th to 26th	0·03″ (Ten days' break.)
On ,, 27th	0·76″
,, ,, 28th	0·00″
From 29th July to 1st August	1·01″
,, August 2nd to August 5th	0·00″
,, ,, 6th to ,, 11th	14·00″

an extraordinary yield of indigo as 32 seers per acre could be obtained *in a single cutting* even with the present Java plant shows that the *principal* factor is apparently the *soil conditions*.

Manuring with sannai and superphosphate produced not only the maximum yield of green plant per acre, of all the Java indigo cut between July 4th and 10th, but also by far the *best quality plant*. The *quality* is clearly as important as, if not more important than, the *quantity*. The writer has in progress, in collaboration with the Imperial Agricultural Bacteriologist and Imperial Agriculturist, a number of experiments which are designed to throw light on the best methods of growing indigo to ensure not only a maximum yield of plant, but a maximum indican content. The plant is being grown under different conditions of manuring, and the changes in quality followed by analyses of the leaf and the proportion of leaf on the plant from time to time. When the plant is cut it is possible to calculate the actual potential yield of indigo from the proportion of indican in the leaf and the actual yield of green plant per acre. The results of this season's trials will be published in detail later.

The reasons for the rapid impoverishment of indigo soils during the past 20 years.

Many planters find it difficult to understand why soils, which grew indigo successfully for 100 years continuously, apparently suddenly, during the last 20 years, have shown marked signs of deterioration. It is not, I think, generally realized that after 1897, the year when synthetic indigo first began seriously to compete with indigo, a complete revolution took place in the methods of indigo cultivation in Bihar. The following sketch based on information kindly imparted to me by Bernard Coventry, Esq., C.I.E., will indicate the general nature of the changes which have occurred and have been responsible for a far more rapid exhaustion, in twenty

years, of the indigo soils than occurred under the old system of working in a century.

Under the old system, up to 1897, the planter took in farm (*thikadarry*) whole estates from Indian landlords usually on a 9 years' lease, very frequently paying down in cash the whole of the 9 years' rental called *zurpaisky* or *surzamanath*. He took into indigo such lands as the landlord had in his own possession, and he contracted with the tenants for from one-seventh to one-tenth of his holding to be sown in indigo. This contract was either on the *asamiwar* system as in Champaran, where the tenant kept possession of his land and grew the crop, or on the *dehai* system as in the districts of Muzaffarpur, Darbhanga and Saran, where the contract was for the planter to prepare the lands and grow the crop himself. It is to be observed that under this system villages or estates were *constantly coming in or going out of lease* and large sums of money were yearly being expended in the shape of rent-in-advance (*zurpaiskies*) paid to the landlord for these leases. *This constant renewal was made easy by the unlimited financial facilities afforded at that time by the Calcutta Agency Houses*; indigo being then a flourishing monopoly industry their money was absolutely safe. When the lease of a village expired it did not necessarily go out of indigo cultivation: frequently the lease was renewed as before and the rent-in-advance paid down in cash. But there was always each year a number of cases where the renewal was not made and the lands went out of indigo only to come back under a fresh lease a few years later. In those days, there was also a certain number of quite new villages coming into fresh lease every year. The two important features to be observed in this system are, first, that the planter was financed to any limit by the Agency Houses which enabled him to treat for the lease of villages or estates with ease and on profitable terms, and, secondly, that *the large number of first leases and of leases renewed some years after the villages had been returned to the landlords, contributed towards keeping up the indigo-producing power of the lands.*

But, further, it was the custom to exchange indigo lands for cultivators' lands on a very considerable scale. Every year the

assistant would go round the cultivation before mahai when the indigo crop was in the ground, and indigo lands which showed the appearance of being worn out he would there and then measure. He would then, in agreement with the cultivators, measure an equal area of their lands and the exchange would be made for the next crop. This exchange was to mutual advantage and was recognized to be so by the cultivator who knew that indigo lands gave him a heavy crop of wheat, etc.

The total area thus affected by the leasing of villages and the *budli* or exchange mentioned would roughly approximate to one-fourth to one-third of the cultivation per annum at Dalsing Sarai. These favourable aspects do not now exist in their entirety. When synthetic indigo began seriously to compete with natural indigo, the Agency Houses tightened their purse-strings, not only in respect of money required for advance rent for leases, but also in respect of ordinary current expenditure. *This deprived the planter of the command he formerly had on the acquisition of fresh land for growing the crop, and it also compelled him to change his methods of cultivation.* He was now obliged to grow country crops (which he had never done before for profit-earning) on a portion of the lands on which he formerly grew indigo. He did this principally for two reasons—in order to establish a system of rotation to replace the means he formerly had of the easy renewal of leases which had now been taken from him, and in order to find money for current expenditure for such portion of the lands as remained in indigo. This arrangement, however, had not beneficial effects equal to the advantages of the old system, nor did it compensate for these. This will be clear from the following considerations.

Under the new system of cultivation imposed by the changes referred to, the planter restricted his area under indigo and introduced country crops. He did not, however, generally speaking, grow the country crops himself, but gave out to tenants the lands, usually manured with seet, on which they grew the crops. The tenants gave the planter either rent or a share of the produce which yielded a greater profit than indigo so far as these particular manured lands were concerned. He also let out into country crops some of

the lands for which there was no seet available, naturally on less favourable terms.

It must be observed that the first effect of this system was to lessen the amount of seet owing to the restricted area under indigo, so that although at first, when there was a plentiful supply of seet, this method promised well, it has gradually led to disappointment, because the area which can now be treated is often so small that the average profit earned on the whole area under country crops is exceedingly small, and sometimes even represents a loss. With the increasing failure of the indigo crop and the lack of seet as a manure which this entails, the present system promises disaster in the next few years. The system has moreover other imperfections. The lands are usually given out to cultivators for three or four years. The aim of the cultivator is to "milk" the land so as to make all the money he can out of it and return it to the planter in an exhausted state. Further, the seet which is given to him aids in the process, for being a manure with an excessive amount of nitrogen, it tends to draw unevenly on the available supplies of phosphoric acid already in defect, and makes the deficiency worse.[1] When introducing this system the planter abandoned the old custom of budli because he grew indigo only in lands which were expected to give a full crop—though in this he has been disappointed also, owing to the development of the so-called "wilt." He finds too that wilt now prevails in lands taken in budli.

I would also emphasize the fact that the "series" of crops grown has not in most cases been a true rotation at all. In a proper rotation the selection of crops is such that the fertility of the land is maintained by establishing a balance between the constituents removed by the crops and those liberated by the ordinary soil changes in successive years. The leguminous crop which always forms part of a proper rotation renovates the soil by replacing nitrogen. But in the case of the planters' lands the crops grown have simply continuously *stripped* the soil of the constituent which they especially lack—available phosphoric acid. Thus to take an

[1] *Indigo Publication* No. 1, pages 36-38.

actual example of a field which was formerly let out to ryots for cultivation, the series of crops was :—

1913	Winter crop, tobacco.
1914	Maize followed by winter crop of wheat.
1915	Maize with *rahar* as *rabi* crop.
1916	Maize followed in October with indigo and mustard together.

It was not surprising to find after this continuous stripping for several years (the earlier record whilst the land was in the ryot's hands is not known) without any application of manure, save one dressing of cattle manure in 1913, that this particular soil when analysed in 1917 contained only 0·037 per cent. of total phosphoric acid and 0·0006 per cent. *available*, even in the top 6″. On many other fields on the same estate the *total* phosphoric acid in the top layer exceeded 0·1 per cent., whilst the *available* was 0·001 to 0·002 per cent. in the *surface* layer. It was also not surprising to find that the indigo and mustard sown in 1916 did not thrive—the mustard dying out completely some time after germination and the indigo following suit.

In the old days, when indigo was grown as the sole crop, the land was ploughed several times and fallowed for a long period. There was no crop in the land from September up to the following February, when the old Sumatrana indigo was sown, during which period—the dry weather—there was ample opportunity for bacterial action in the soil to liberate a fair supply of mineral plant food. Only the one crop—indigo—was grown in the year. Under the present system *two* crops are frequently taken out in the year, when indigo is not grown, and these are often very exhausting crops—such as tobacco. When Java indigo is sown in October, it frequently immediately follows another crop, either of indigo or some cereal such as maize, without the soil having a chance properly to recover. With Java indigo, which remains on the land for nearly a whole year (October to September), two or more cuttings are taken which is equivalent to growing two ordinary crops.

To sum up: The changes imposed on the cultivation in Bihar by the appearance of synthetic indigo in 1897 have, during the past 20 years, greatly altered the general character of the soil and necessitated a fresh method of treatment. Planters have been deprived

of the financial aid which was formerly available to enable them to take leases of large parcels of land in which exchange was easily assured, either by the taking of first leases, the renewal of old leases after the lapse of some years, or by the budli or exchange of indigo lands with cultivators' lands. In place of these advantages they have had to ring the changes on the same land under a system leading to certain, and in many cases rapid, exhaustion. When lands have been let out to ryots, it has been to grow exhausting crops such as tobacco and chillies, and the soil returns to the planter in a very impoverished condition.

There are of course notable exceptions to the conditions depicted above. Thus planters frequently point out to me that certain fields have given good crops of indigo continuously year after year for an unlimited period. These fields are usually the sites of old villages and are of high fertility, mainly owing to the accumulation of human and animal excreta for generations. In these the process of exhaustion will naturally take far longer before they show a failure of crops. But such cases are the exception, not the rule.

Again, many planters have expressed to me their difficulty of understanding how soils which gave good indigo crops for a hundred years should quite suddenly show a rapid falling off such as followed the appearance of wilt in 1907. Actually this is the very behaviour which was to be expected. It is quite easy to understand that if a soil originally contains 100 parts of "available" phosphate and the crop removes one part each year, no marked falling off of crop will occur for 98 to 99 years, but that then quite suddenly the crop will fail to an increasing extent each year because it can no longer easily obtain the one part of phosphate corresponding with a full crop. It must be clearly understood that a *certain* amount of regeneration takes place each year in the soil owing to the liberation of *water-soluble phosphate* by the ordinary soil agencies (bacterial action, following cultivation or fallowing) acting on the insoluble mineral phosphates (in the analyses termed "total phosphate") always present in the soil. But the trouble at the present time is that the amount of this regeneration each season is not sufficient to give a full or even a good crop in the case of indigo. Moreover, this

regeneration takes place only in the *surface* layer of the soil where the soil agencies are most active. The soluble phosphate produced is rapidly used up by surface growing crops, and there is no opportunity for the small amount of soluble phosphate liberated to wash down into the lower layers of soil (where the Java plant mainly feeds) to renovate them. The consequence is that soils are frequently found which still give good or fair results with oats, barley or country crops, but fail more or less completely with indigo. One of the most striking instances of this kind may be cited—Byreah, Field No. 1* where the following analyses were obtained :—

Depth	Total P_2O_5	Available P_2O_5
0—6″	0·1371	0·00505
6″—12″	0·1273	0·00136
12″—36″	0·1049	0·00020

Here the amount of available phosphate in the *surface* layer is relatively very high for Bihar—not far short of the quantity generally regarded as necessary for good fertility in Europe (0·01 per cent.). But below 12″ the amount of available phosphate is extremely small (0·0002 per cent.). The behaviour of indigo grown in this land exactly corresponded with what would be expected from the analysis. The plant grew very well for 2 or 3 months, but when it reached a height of about one foot, growth was checked and large patches died out. The deep feeding roots of the Java indigo had reached a layer of soil in which there was no longer proper nutrition.

The complete revolution in the system of cultivation in Bihar, which followed the capture of the indigo market in 1897 by the synthetic dye, led to a far more drastic stripping of the soil. Under this new system the soils are now showing signs of rapid deterioration. If crops are to be maintained in the future, the method which has been adopted in all civilized countries—scientific manuring—must be introduced. Some 20 to 25 planters have expressed their willingness to make trials on their estates with superphosphate this season. The principal difficulty has been to obtain superphosphate, but it is hoped that in several cases at least supplies will be at hand before the rains cease, so that the effect can be seen on next year's crop.

* For full particulars and analyses see *Indigo Publication* No. 1, page 52.

TABLE

Statement of produce from Java plant at various stages

Date	Particulars	Bighas cut	Acres cut	Green plant	Average plant per bigha	Indigo made per press of 20 srs.	AVERAGE per bigha	AVERAGE per acre
1918		B. C.		M. S.	M. S.	M. S.	S. C.	S. C.
June 17 ...	Kept fallow 12 months (1)	12 0	10·47	998 0	83 20	2 20	8 5	9 8
,, 18 ...	Superphosphate and sannai (2)	11 0	9·60	903 30	82 6	3 0	10 14	12 8
,, 19 ...	Jamoona Singh's *khuski* (3)	2 15	2·40	500 20	182 0	1 0	14 8	16 10
,, 22 ...	Manured with seet-water (4)	3 10	3·05	667 10	190 20	1 3	12 4	14 1
July 4 ...	Superphosphate and sannai (5)	4 12	4·01	614 0	133 20	3 0	26 1	29 14
,, 5 ..	Seet dug in with *kodali*	9 10	8·29	662 0	69 20	2 20	10 8	12 1
,, 6 ...	Seeted land, sown in February along with Sumatrana (6)	9 0	7·85	938 30	104 10	3 0	13 5	15 4
,, 7 ...	Seet dug in with *kodali*	15 0	13·09	1,103 0	73 20	3 20	9 5	10 11
,, 8 ...	Java of Bhoji Chaper mixed with February sowing	11 10	10·04	889 10	77 10	3 0	10 7	11 15
,, 9 ...	February sowing near Amla's Derakar-singh Tewary Toke	15 17	13·83	1,004 30	65 6	2 0	5 0	5 12
,, 10 ..	February sowing and Hiranda plant	14 0	12·22	954 20	68 7	3 0	8 9	9 13
	TOTAL ...	108 14	94·85	9,235 30	85 0	27 23	10 3	11 10

(1) This land is of better quality than
(2) Note the coldness of the water. The
(3) Java in this field grew to a tremendous
(4) Java in this field grew to a tremendous
(5) Height of crop 5 to 6 feet, *covered with*
(6) This Java was put down at the same

N.B.—There is a very big difference in the produce from 18th June to 4th July from the same sun from 27th June to 4th July.

I.

of mahai and from various qualities of land at Moniara Concern.

PRODUCE per 1,000 c.ft. of vat	PRODUCE per 100 mds. green plant	PRODUCE Green plant per one maund indigo	Indigo made by cake measurement at 7 srs. per inch	AVERAGE PRODUCE per bigha	AVERAGE PRODUCE per acre	AVERAGE PRODUCE per 1,000 c.ft. of vat	AVERAGE PRODUCE per 100 mds. green plant	AVERAGE PRODUCE Green plant per one maund indigo	Temperature of water in khajana. °F.
S. C.	S. C.	M. S.	M. S.	S. C.	S. C.	S. C.	S. C.	M. S.	
13 14	10 0	399 0	2 28½	9 0	10 5	15 1	10 14	368 0	86
16 10	13 4	301 10	3 6	11 7	13 2	17 8	13 15	284 20	83
11 1	8 0	500 20	1 0¼	14 10	16 12	11 3	8 0	497 15	88
8 5	6 8	612 0	1 5	12 13	14 12	9 6	6 11	593 0	86
25 0	19 8	203 20	3 9½	28 2	32 4	26 15	21 1	189 20	90
20 13	15 1	264 30	2 25	11 0	12 10	21 14	15 13	252 10	88
16 10	11 8	346 30	3 13	14 12	16 15	18 7	14 2	282 10	88
19 7	12 11	315 0	3 30½	10 0	11 7	20 14	13 10	293 0	88
16 10	13 7	296 10	3 13	11 9	13 3	18 7	14 15	267 10	88
11 2	7 15	502 10	2 7½	5	6 5	12 1	8 11	458 20	88
16 10	12 9	318 0	3 16½	9 12	11 2	19 0	14 4	279 20	89
16 2	11 15	334 30	29 34¼	10 15	12 9	17 7	12 14	309 0	...

that treated with sannai and super.
day was also very cloudy and cold.
height, 8′ at the least and more wood than leaf.
height, 8′ at the least and more wood than leaf.
leaf from top to bottom.
time as Sumatrana, February and March.
field. This is attributable to very heavy rain in June, 15·60″, and there being a dry spell of hot

SOME OF THE PROBLEMS ARISING OUT OF THE SUCCESSFUL INTRODUCTION OF AMERICAN COTTON IN THE WESTERN PUNJAB.*

BY

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THE introduction of American cotton in the Punjab by the Agricultural Department has brought out a number of problems, partly owing to the difficulties experienced by the Department in this work, and also on account of the success which has attended the work. In order to appreciate these difficulties it is necessary briefly to outline the outstanding features of the work. Work on American cotton started at Hissar in 1902 and at Lyallpur in 1903 and 1904. Previous to that there were some plants of American cotton to be found among the *desi* or country cotton grown, especially in Shahpur, Lahore and Jullundur. The very severe boll-worm attack of 1905 and the somewhat less severe attack in 1911 were found to affect American cotton to a very much less extent than country cotton. The experience of 1905, and especially of 1911, had a very marked effect on the attitude with which zemindars regarded American cotton. The policy of the Agricultural Department up to 1912 was to import seed from Dharwar every year though most of the zemindars growing this cotton kept their own seed. Experience in 1913 showed clearly that the sowing of seed acclimatized in the Punjab and plants of the rough-leaved type was the only safe policy to adopt. It had appeared for some years that imported seed was not very reliable as it contained so many different types. The Department in 1912 and 1913 put out two special

* A paper read at the Fifth Indian Science Congress, Lahore, 1918.

selections which had been handed over by the Economic Botanist in 1910 for trial at the Lyallpur farm. One of these, *viz.*, 4 F, proved to be a very safe plant and the area under it since 1913 is roughly as follows :—

1913 ...	...	...	...	100 acres.	
1914 ...	...	..	...	4,000 ,,	
1915 ...	...	...	...	10,000 ,,	
1916 ...	...	...	...	30,000 ,,	
1917 ..	...	...	...	120,000 ,,	probably 140,000 acres.

The total areal under American cotton in 1917 was 274,000 acres, of which, as will be seen, over half was pure 4 F, and probably another quarter was impure 4 F from mixed seed obtained from ginning factories. The total area under American in 1911 was probably under 10,000 acres and reached 30,000 acres in 1913. It will be seen that since 1911 the increase has been rapid and phenomenal. The reason for the comparatively slow progress from 1903 to 1911 was mainly connected, in the first place, with the fact that the plant was not acclimatized, and, secondly, with the fact that the premium over *desi* cotton was at first only R. 1 to R. 1-6 per maund even in cotton sales and generally only a few annas per maund in the *mandi* or market. Previous to 1908 the cotton used to be sold by arrangement through the Agricultural Department at a premium of R. 1 to R. 1-8, but, owing to delays in recovering money and other difficulties connected with a monopoly, Mr. Milligan, who was then in charge of the work, started auction sales. The quantities at the latter were generally from 300 to 500 maunds and premiums up to R. 1-8 per maund were realized. Sales were temporarily dropped in 1911 and 1912, but were started again in 1913 by the writer both with a view to obtaining the seed of 4 F and to stimulate competition. By 1913 this cotton was becoming known in Bombay, and it was easy to get R. 1 to R. 1-4 premium in the ordinary market. At the sales the premium went up to Rs. 2-8 and Rs. 2-12. Since then the number of sales have increased rapidly until this year the Department will have sold in this way at fourteen sales over 100,000 maunds

[1] *The Agricultural Journal of India*, vol. X, pt. IV, 1915 ; vol. XI, pt. III, 1916 ; vol. XII, pt. III, 1917 ; vol. XIII, pt. I, 1918.

valued at roughly £130,000. Since 1914 all the cotton (*kapas*) coming to the sales is classified according to purity, and no American cotton with over 5 per cent. *desi* cotton admixture is sold at the auctions. Premiums averaging Rs. 4 per maund were obtained in 1916, and the highest price reached this year has been Rs. 21-15 per maund, when country cotton was selling at Rs. 15 per maund. Although the cotton sold through the Department sales is only about 10 per cent. of the whole, the value of these sales has been enormous both in attracting new buyers and in securing a wide and open market. This year four buying agencies representing Bombay and Ahmedabad mills have come forward as active buyers. Since 1915 Messrs. Tata & Sons, who were the first to come into the market from Bombay, have facilitated our task and helped to establish the market. Ordinary Punjab cotton which used to be grown exclusively in the Colonies is classified in Bombay as Sind-Punjab and fetches the lowest price in the market. Punjab-American is quoted since 1915-1916 at from Rs. 20 to Rs. 40 per candy (784 lb.) over Broach, or Rs. 100 to Rs. 150 or more above Punjab *desi*. This means Rs. 4 or Rs. 5 per maund of *kapas*, which is the premium this cotton is fetching at present. One of the conspicuous features with reference to the introduction of a new cotton in India is the slowness with which the trade responds to any change that takes place. This holds true for both superior and inferior varieties and consequently tends to put a premium on work with low grade high yielding cottons such as "Aligarh white" in the United Provinces and "Roseum" in the Central Provinces.

The difficulties encountered have been therefore as follows :—

(*a*) From 1903 to 1911 the problem was to get a fair premium. The cotton began to command premiums independently of sales in 1911, but this premium was far too low and generally only As. 8 to As. 12 instead of Rs. 2 or Rs. 3.

(*b*) With resumption of sales in 1913 premiums went up. The quantity had increased from 10,000 acres in 1911 to 30,000 in 1913. Since 1911 there has been no looking back.

(*c*) In spite of increase in area it was only by bringing in and encouraging outside bidders, *e.g.*, Tatas and Bombay and Ahmedabad mills that fair prices could be obtained. This was largely owing to the combination of the local ginning factories who in the Punjab buy cotton, and these resented the organization of the zemindars by the Agricultural Department and in many cases combined to wreck the sales. Attempts to eliminate abuses in "weighments," "arbitration," and "rejections" met with strong opposition, and factory owners in many places, *e.g.*, Lyallpur, have not bid at our auctions for two or three years. With the assistance of Mr. A. J. W. Kitchin, C.I.E., Deputy Commissioner of Lyallpur, the Department drew out a series of rules and conditions regarding "weighments," "allowances," and "arbitration" to remedy some of the above abuses and these have worked with conspicuous success. The cultivator is beginning to realize the advantages of "co-operative sale" and great developments in this direction may be expected in the future.

(*d*) In spite of assistance through auctions it had been noted that prices in outlying markets which were some distance from Lyallpur tended to be well below Lyallpur prices. To remedy this partially at any rate, it was decided to post up Lyallpur and Bombay prices daily at the chief markets. The idea is to keep zemindars informed of the real value of their produce and of the general trend of the market. There has been a marked effect already and in all outlying markets prices have advanced closer to Lyallpur prices. At Tandlianwala which is about 40 miles from Lyallpur by road and over 100 miles by rail, prices up to this year were sometimes as much as Rs. 2 per maund below Lyallpur prices, but in the present year have not been more than As. 6 per maund lower. The effect in the Lower Bari Doab has been

even more pronounced and has in consequence reacted very favourably on the growing popularity of cotton as a crop.

(*e*) Much of the American cotton produced in the Colonies was sent to Bombay mixed with *desi* cotton, the latter being put in to the extent of 10 to 25 per cent. and sometimes even more. This mixing was partly accidental owing to over-crowding in ginning factory compounds and also mainly deliberate. Zemindars grow these cottons pure nowadays, and it is rare to see a field of American with over 5 per cent. *desi*. It is easy to detect mixture in the *kapas* and zemindars are heavily penalized both in the Department's auctions and by factory owners for admixture of *desi* cotton; hence the rapid disappearance of mixtures in the field. When the cotton is ginned it is very difficult to detect even 10 per cent. mixture, and hence mixture in baled cotton is not uniformly or adequately penalized in Bombay. This practice must ultimately affect every one, even those who try to send American pure to Bombay. A remedy must be found up-country. Ultimately no doubt it will be necessary to license ginning factories and use this handle to penalize mixing. As a first step in remedying this and other evils, the Punjab Government have accepted certain suggestions ot the writer regarding conditions under which any new factories can be built. Probably some sort of combination among factory owners in the form of an Association which could be recognized in Bombay is the only reliable and constructive manner of tackling this difficulty. Membership of this Association would involve responsibility and an undertaking to send cotton of definite purity. The penalty for breach of these conditions would have to be a heavy fine or loss of membership. Such an Association would command confidence in Bombay and

be to the interest of ginners themselves as well as that of zemindars.

(*f*) *Pure seed.* With concentration on one type, *viz.*, 4 F, the whole of the American cotton will in time become standardized. Already over half the American cotton grown here is of this variety, and the proportion will increase greatly in the next two or three years. The Department hopes to sell enough seed for 200,000 to 250,000 acres of this type in the coming season. The seed is sold at a premium of 40 per cent. and covers all expenses involved in premiums and in supervising ginning, etc. As the seed rate is only 8 lb. per acre the increased price of seed amounts to only As. 3 per acre and farmers gladly pay the necessary premium. It is possible that a better type than 4 F will be forthcoming. In the course of a few years it will certainly improve as selection is carried through. Owing to the existence of a number of large estates in the Colonies there will be no difficulty in keeping seed pure. A good deal of attention must be concentrated on this work as it will become of growing importance as time goes on.

(*g*) The greater the quantity of a good class of cotton which can be grown the easier it is to secure fair prices for the produce. So long as the quantity is small only a few buyers can secure the cotton, and competition is in consequence much restricted. With the extension of irrigation the area under American cotton will, of course, increase, but at present an area of 450,000 acres will represent the limit in sight. Cotton undoubtedly pays better than wheat in the Western Punjab, and, in the case of American cotton, farmers are beginning to realize that it is a very safe crop.* The great question of increasing summer

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* See paper by the writer on this subject contributed to the Punjab Irrigation Congress, 1918.

supplies in the canals when the rivers are in flood is becoming therefore of even greater importance than formerly. This is a matter of very wide and deep significance to the future prosperity of the province. The foundation for the success of such a policy is being laid in the introduction of American cotton. Immense developments are possible in this respect in Sind also, where staple cotton of much finer quality than can be grown in the Punjab only awaits the advent of a secure irrigation system. Such development in Sind would react beneficially on the Punjab as it would tend to raise the price of Punjab-American.

THE CONSOLIDATION OF AGRICULTURAL HOLDINGS IN THE UNITED PROVINCES.

BY

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(Continued from page 230, vol. XIII, pt. II.)

PART II. OUTLINE OF PROPOSED CHANGES.

THE first part of this paper has been devoted to an exposition of the more important economic principles affecting the consolidation and enlargement of agricultural holdings and to defining and finding a solution in general terms of the problem of establishing permanently a higher standard of living. The practicability of attaining these objects has purposely been left unconsidered. It was intended only to obtain a clear view of the right goal to aim at; because such a clear view is necessary before the practical measures to be taken for the purpose of changing the present evil can even be discussed fruitfully. Also in order to obtain a simple and clear view of the object to be aimed at I purposely avoided details; and these may in some cases be filled in here.

CONSOLIDATION OF ALL OWNERS' HOLDINGS NECESSARY.

It is necessary to distinguish between the scattering of the strips of one *mahal*, or legally recognized unit of ownership, and the scattering of strips held by one cultivator, whether from one or more owners. For clearness of diction I use the term *unit of cultivation* to denote the whole of the fields actually cultivated by one man, or by a family or partners, as one business concern, whatever the ownership of fields may be. The cultivator may hold some of his

fields as a tenant with occupancy rights, and others as a tenant-at-will, and himself own yet other fields, thus making up a cultivating unit of, say, 10 or 12 acres. The scattering of strips in ownership* would not be a matter of vital concern were it not that it involves almost of necessity the scattering of the fields of a cultivating unit, because a tenant would experience very great difficulty in making the numerous agreements which would be needed to get a consolidated cultivating unit. I come, therefore, to the conclusion that the only practicable course is to adopt a policy of abolishing both scattered ownership and scattered tenants' holdings at the same time by consolidating the units of ownership.

In cases when the ownership is not at present scattered—that is to say, where a whole village, or a large part of a village, is held as one *mahal* by a 16-anna shareholder, or in imperfect partition—it would seem to be feasible for the owner, or the two or more shareholders, to agree to rearrange the holdings for letting purposes. One obstacle to this is the novelty of the idea, and the consequent opposition which would be raised even by tenants-at-will as a united body; and a further obstacle is the absence usually of any expert agent to carry out for the landlord the re-division of his land into the fresh holdings. The land needs to be re-surveyed, and new holdings graded in size according to the quality of the land, distance from the *abadi*, etc. The principal difficulty, however, is the occurrence of occupancy holdings with their fields thoroughly intermixed with the fields of tenants-at-will. The occupancy tenants cannot, under the present tenancy law of the Agra province, be bought out; and it is exceedingly difficult to arrange an exchange of fields which will be regarded by occupancy tenants as mutually satisfactory. Consequently nothing is done.

Advantages of consolidation admitted.

Yet scattered holdings are admitted to be a serious evil which is frustrating the progress of agriculture in several parts of India.

* Both *mahals*, and *pattis* thereof, are frequently composed of scattered fields in different parts of the village.

I take it to be generally agreed by agricultural experts that it is desirable in most places to consolidate scattered holdings more or less completely, the idea being that a holding should be compact, except where the nature of the country is such that the safest and most economic business is to carry on a mixed farming requiring river meadow lands, and plains or uplands in due proportion.

The disadvantages of the present condition of holdings and the advantages of re-stripping have been so well stated by many authorities that I need do no more than indicate my agreement with their statements. In 1912, Mr. Moreland, then Director of Land Records and Agriculture in the United Provinces, prepared a note for the United Provinces Government[1] which was printed and circulated by this Government. His proposals will be considered later on in this paper. In the same year Mr. G. Keatinge dealt briefly with this question in the Deccan.[2] In 1916, Mr. Burt read a paper before the Science Congress at Lucknow on "The Re-alignment of Agricultural Holdings";[3] and more recently a committee appointed by His Highness the Gaekwar of Baroda has fully investigated the question of the minute subdivision of holdings in that State.[4] Dr. Harold Mann has also called attention to the evils of excessive subdivision and cultivation of scattered fragments of land. He points out that cultivating a holding of small scattered fields has the great disadvantage of very small holdings in preventing the use of machinery and labour-saving appliances, whilst also "it has all the evils of large holdings, in that it prevents the adoption of really intensive cultivation by any holder."[5] In a subsequent publication he has amplified this study.[6] The importance of the

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[1] Dated 29th June, 1912, and enclosed under No. 19 I-505-1912 of 1915.

[2] *Rural Economy in the Bombay Deccan* (Longmans), pp. 40-2, 51-5.

[3] Reprinted in the *Agricultural Journal of India*, Special Indian Science Congress Number, 1916, p. 33.

[4] *Report on Consolidation of Small Scattered Holdings;* issued by Baroda State Printing Works. As. 10.

[5] "Economics of a Deccan Village." *Indian Journal of Economics*, vol. I, p. 420. Reprinted in the *Agricultural Journal of India*, July, 1917.

[6] *Land and Labour in a Deccan Village;* University of Bombay: Economics Series No. 1 (Oxford University Press), 1917—Chapter III: The Land and its Divisions and the Holdings.

question is being widely recognized in the Bombay Presidency and it has received attention in the Bombay Legislative Council on more than one occasion during the past two years.[1]

Scattered strips characteristic of primitive society in all countries.

The cultivation of scattered strips is a well known and very widely distributed economic phenomenon which seems to be characteristic of a certain stage of the evolution of primitive society in all races of mankind. The first three stages of the evolution of society are (1) families living by hunting and gathering wild fruits; (2) nomadic tribes living by pasturing domesticated animals, and gathering wild vegetable products; (3) "extensive" cultivation, as it is called by economists.[2] Nomadic tribes, having learnt to take occasional catch crops, gradually settled down and began to break up patches in the jungle. They had no rotation of crops, but broke up new patches in the waste as required.

The *abadi* is characteristic of the most primitive agricultural people. They settled in a definite spot for the village, and thus came a fourth stage. All the lands near the *abadi* became cultivated by the growing population of the village and the children of large families divided the home fields and had to make their cultivated area up to a size sufficient for maintenance by taking in fields from the waste. The fifth stage is the almost complete absorption of the cultivable waste, except what is needed for grazing land; and the sixth stage, the subdivision of holdings through the growth of population until the minimum economic size is reached, corresponding with a slightly improved cultivation which is forced on the people for maintenance. Here a stage of economic equilibrium is reached in which population must be stationary and the death-rate equal to birth-rate on the average, though owing to variations of the seasons,

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[1] Proceedings of the Bombay Legislative Council; especially the 14th and 15th March, 1916.

[2] Cunningham, W. *Growth of English Industry and Commerce during the Early and Middle Ages*, 5th ed., p. 33. *Cf.* Bucher. *Industrial Evolution*, Trans. Wicket (Holt & Co., N. Y.), pp. 45 *et seq.*

it is largely by famines and epidemic diseases that the average death-rate keeps the population down.

This is the last stage characteristic of primitive civilization, and society may remain in this condition for centuries. When advanced civilization begins to demand progress of the agricultural community, two lines of advance are possible: (1) by education and co-operation, and particularly by instruction of the people in the methods of intensive agriculture, so as to increase the productivity of the small scattered holdings, as has been done in France, Japan, Denmark and Ireland; (2) the other line of advance is to promote improved efficiency in agriculture by a re-arrangement and enlargement of holdings. The former method would appear to be very limited in its scope—in economic phraseology, the marginal productivity of additional effort devoted to improving the culture of small holdings declines rapidly. The only exceptions are in places where there is a particularly large demand for special crops, *e.g.*, the environs of Paris, London, or Calcutta.

For the production of the staple crops the economies of large scale production on compact holdings are so great that small holders of scattered fields can hardly make a living in competition, where the market is ruled by a considerable volume of production on a large scale. They are handicapped not only in labour, but by the difficulty of employing capital in the form of machinery and permanent improvements. This is well understood in England. It is easy, therefore, to establish two propositions: (1) that the progress of national economy, that is the welfare of the country as a whole, demands the cultivation of all staple crops on large holdings with abundant capital, because of the great economies, and therefore increase of wealth, which would thus be realized; and (2) that if large holdings become numerous in some parts of India, *i.e.*, Punjab, Central Provinces and parts of the United Provinces and Bengal, the system must rapidly (that is in 20 years or so) be extended throughout the whole of India, because the cultivation of staple crops on small holdings will become so unremunerative as to yield less profit than will support the existing standard of living.

Necessity for Government intervention.

It may be admitted that the economic welfare of India requires the introduction of the system of cultivation on large compact holdings, and yet be questioned whether there is need for Government intervention in the matter. It may be answered at once that it is highly probable that, were it not for the very great economic friction created by the primitive land tenure customs and laws, the change would have come about already. Unfortunately the effect of British legislation in India, which created occupancy tenures and permanent ryotwari and zemindari holdings, has been greatly to increase the difficulty of change; and it may be confidently asserted that the difficulty of re-arranging and enlarging holdings is now so great that the expectation of a profit three times greater than that which may be fairly anticipated would not be a sufficiently powerful economic force to bring about the change. It is, therefore, essential that the Government should intervene, and by means of special legislation facilitate the consolidation and enlargement of holdings.

The experience of other countries supplies ample precedent for the special intervention of Government to secure this end. In all countries the last stage of primitive tenure involves not only an intermixing of fields, but common rights in grazing on the pasture and waste, and, sometimes, on the stubble. Such rights have everywhere proved too complex and stubborn to be liquidated by agreement over any large area of country, and special legislation has proved necessary. The pioneer country in this special legislation was England; but many other countries have been obliged to undertake special legislation as noted above. As the change has been carried practically to completion in England it will be profitable to glance briefly at the methods which were adopted and the results obtained in that country.

The enclosure movement in England.

In England the consolidation and enlargement of holdings was nearly always accompanied by the erection of a ring fence about the new holding, which was usually partly carved out of the common land. Hence the process variously called re-stripping, re-alignment,

consolidation, redistribution, re-partition, or reorganization, was in England termed "enclosure." The type of cultivation, which was practically universal in England during the Middle Ages, is known as the "open field system." The lands of the manor (or village, as we should call it in India) were classified as follows: (1) the demesne close (or private compound and home fields of the lord of the manor); (2) arable fields; (3) meadow land, beside a stream or river; (4) common pasturage on which the villagers had limited grazing rights; (5) waste, with unlimited free grazing until later centuries when the growth of arable and pasture absorbed most of it; (6) forest, with well-defined rights of the villagers for taking fuel and timber. The villagers, whether free-holders, villeins in servile tenure, or tenants-at-will of the former or of the lord of the manor, cultivated a large number of strips scattered throughout the arable fields, the number of separate strips being from 4 or 5 up to 50, but the most frequent number was probably about 20. The standard size of strip was the acre, 220 yards (one furlong) in length and 22 yards wide; but half and quarter acre strips were not uncommon, besides irregular plots caused by the contour of the ground. The acre was supposed to be the area which one plough with four, six or even eight oxen, could plough in a day, and as no cultivator owned as many oxen as were supposed to be required for the plough, a co-operative system of assistance prevailed. Whilst the demesne (equivalent to *sir*) lay partly in enclosed home fields, the larger part of it was in scattered strips in the open fields. The arrangement of the strips in the arable fields is well shown in a map published by Mr. F. Seebohm in his book "The English Village Community."[1] The best description of the English field system prior to the enclosures is to be found in a recent book by Professor H. L. Gray of the Harvard University.[2] He reproduces a number of maps of old parishes showing clearly the arrangement of the strips in the arable fields and the manner in

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[1] See frontispiece and plate opposite page 26. The latter plate is also reproduced by Cunningham, *ibid.*, page 44. I have relied considerably on Cunningham's account of the mediæval system of agriculture and would refer readers particularly to pp. 73-8 and pp. 526-34. An elementary sketch of the manorial system is contained in Gibbin's *Industrial History of England* (Methuen), pp. 5-22.

[2] *English Field System* (Harvard University Press), 1915.

which enclosures usually began to be made around the village dwellings which were concentrated in one place along one or two roads. Other sporadic enclosures of the meadow land were made for pasturage purposes, the initiative being usually taken by the lord of the manor enclosing part of the demesne.

The manner of cultivation differed in various parts of England and changed slightly in the course of centuries. The more primitive method was known as the "two-field system," and it involved letting the land lie fallow every alternate year. The arable strips of the village were grouped in two open fields, perhaps 200 acres or more each. In one year all the cultivators were obliged to leave all the strips in one of the fields fallow because the cattle were turned out to graze on the fallow land, and so the whole of their cultivation was done in the strips of the other field. Next year the fields were changed. A gain of cultivating an additional one-sixth of the total area was made by adopting a three-course rotation which involved the arable lands of the village being laid out in three fields, and was termed the "three-field system." Each field was laid fallow in succession so that each of the three fields was put through the following rotation:—

(1) Ploughed and sown with wheat in October, reaped the following August; grazing on stubble during autumn.

(2) Ploughed in March and sown with barley, oats, beans or pulse; grazing on the stubble during the autumn.

(3) Land ploughed twice, but lying fallow, and open to cattle.

The three-field system seems to have gradually superseded the two-field system except in certain districts where the latter remained until both the systems gave way before the modern method of convertible husbandry in which periods of grass growing alternated with arable culture. It was the profit of sheep farming and cattle breeding which first led to the withdrawal of lands from the common cultivation and their enclosure with fences. This movement began in the east of England in the fifteenth century and resulted in a considerable depopulation of certain parts of the eastern counties. The incentive of sheep breeding did not extend over the rest of the

country, and probably also there were greater legal difficulties in making enclosures in other parts of England, a larger percentage of land having been freehold originally in the eastern counties. Sporadic enclosures took place throughout the sixteenth century, but it was not until proper ideas of convertible husbandry and drainage were learnt from the Dutch in the seventeenth century that a widespread interest in the consolidation of holdings and their enclosure began to be evinced.

The best account of the enclosure movement is given by Professor Gonner in his book "Common Land and Enclosure" (Macmillan, 1912). He has traced from contemporary documents the whole course of the movement and has described the legal methods adopted at various times to carry out the enclosures. In the seventeenth century, the enclosures were mainly carried out by agreements of the owners, which would mean the lord of the manor, the copyholders and one or two free-holders. It was usually considered necessary to render the agreement indefeasible by obtaining a decree of the Court of Chancery. A few extracts from Gonner's book will be of interest.

"During the seventeenth century, agreements were even more important. The testimony as to their prevalence is strong and spread throughout the period. They find mention in the record of the action of the Privy Council, between 1630 and 1640, which illustrate the difficulties which beset those anxious to agree, and also the methods whereby a reluctant consent was often wrung from those who were unwilling. Again, in the controversy which raged a little later as to the effect of the enclosures in the Midlands, and particularly in Leicester, we are told of the lords of the manors and others anxious to enclose that if they cannot persuade, they commence a suit in law." [1]

The difficulty of this method was that "the decree would not affect rights which were claimed by others than the parties to the case...... It may be suggested that it was the recognition of this limitation which led to the disuse of this particular method. Its

[1] *Ibid.*, pp. 53-4.

inability to procure anything like a binding or universal consent, together with the difficulty attending purely voluntary, and even registered agreements, led to the open and steady demand for powers to prevent obstruction which could be obtained only by application to Parliament." [1]

"This new stage on which enclosure enters under parliamentary authority admits of division into three periods. During the first, which extends through the eighteenth century to the general act of 1801, the growth of the private acts may be traced from the very rudimentary form of the earlier acts to that high degree of development where, by reason of the very uniformity and complexity of the provisions included on each occasion, a general act was rendered not only feasible and useful but essential. The second period is from 1801 to 1842-5[2] and includes the private acts which were passed in accordance with the provisions of the general act. After 1845 the powers hitherto exercised directly by Parliament, and through commissioners specially appointed by act, were delegated to different permanent bodies established by act, and subject to Parliamentary control, inasmuch as their decisions or orders had to remain on the table of the Houses before becoming operative." [3]

The usual procedure in making enclosures by private act was, at the close of the eighteenth century, when the technique had fully developed, as follows.[4] Proceedings were commenced by a petition for an act, which involved considerable expense whether the act was ultimately obtained or not, and this placed the initiative in the power of wealthy owners only. A meeting of owners and others known to be interested had to be called and a preliminary agreement of all those who could be got to agree to submit their interests to commissioners sanctioned by Parliament was included in the petition. In most cases the commissioners, usually three in number, were named in the petition or draft bill. The commissioners were usually paid. Probably the best "were practical men with knowledge of

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[1] *Ibid.*, pp. 55-6.
[2] That is, to the general act of 1845.
[3] *Ibid.*, pp. 59-60.
[4] This is abstracted from Gonner, *ibid.*, Book I, Chap. III.

farming and surveying, who gained experience from being employed in enclosure after enclosure."[1] The powers of the commissioners were considerable and each was bound by oath to administer with justice. Their award was final, except as to the title to property. The local proceedings were arranged with a view to publicity, and usually opened with a public meeting to consider the draft petition. After such negotiations and meetings as proved necessary, signatures of the draft bill were obtained and witnessed, showing the degree of dissent, if any; and the act was then usually passed by Parliament with little or no alteration, if in the usual form.

The commissioners being now appointed called a public meeting at the locality, at which they usually took the opportunity of obtaining public consent, or at least hearing objections, in regard to the surveyors and valuers they proposed to appoint. The survey and valuation, the latter parcel by parcel for every holding, were then made. Besides fertility of the soil, drainage, situation and cost of enclosing were always taken into account. The proposed allotment of new fields was then made, and a revaluation of the land on this basis. Upon the improvement of value thus ascertained was first assessed the cost of the enclosure; and then the rights of tithe, various rights of the lord of the manor, and of the forest ranger, etc., were compromised. The commissioners then proceeded to lay out the village anew, apportioning land of amount corresponding in the proportion of new total value with the proportion of estimated value of the previous rights of each recipient. "The new enclosures were as a rule regular and compact.... They lay, in the case of some, at a considerable distance from the little village of farm houses, while others had the advantage of having their holdings conveniently near."[2] One of the most important duties imposed on the commissioners was the laying out of roads, which were to be planned before the land was distributed. The public roads were to be constructed at the common charge of the enclosure. Private roads for access to holdings were planned by the commissioners and the expense apportioned by agreement amongst those whose holdings they served.

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[1] *Ibid.*, p. 75.

[2] *Ibid.*, pp. 82-3.

"There is no doubt that the roadmaking performed under the enclosure acts co-operated with the increase in and improvement of roads under the Turnpike acts [1] in effecting the great change in the means of locomotion which marks the end of the eighteenth century." Fencing or hedging of the holdings was required to be done, and this bore heavily on the owners of small allotments, so that they frequently had to sell their rights to large holders.

The expenses of enclosure were heavy and caused loud complaints by the smaller owners. The Board of Agriculture has calculated that the average area affected by the acts was 1,162 acres each; and that the average expenses were as follows:—

	£
In obtaining the act	497
Survey and valuation...	259
Fees of commissioners and pay of clerks, etc.	344
Fences	550
	1,650

This amounts to an average of £1 8*s*. 1*d*. (or Rs. 21-1) per acre; but apparently it does not include the assessed cost of roads. The appreciation of value was considerably more than this for the larger holdings; but hardly equal to the expense for the smallest of the new holdings.

The subsequent history of the new compact holdings is one of gradual consolidation and enlargement. Immediately the re-distribution was effected and the land fenced, many cottagers and small holders found themselves possessing a field of 5 to 10 acres, or two fields aggregating 15 or 20 acres. They failed to make them pay, got into debt and sold their holdings, usually to the lord of the manor, who threw such additional fields into his compact farms on

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[1] "Turnpike Trusts originated in the desire to maintain and improve roads. In many cases, however, they are directed to the provision of new roads (see pp. 1851, xlviii; County Report, Kent). While the first act was in the seventeenth century, such acts are scarce till Anne, and not really plentiful till towards the end of G. II., thenceforward they are very numerous. The trusts were usually for limited periods, but these were open to renewal. By the beginning of the eighteenth century, the length of road under Turnpike Trusts was about 17,000 miles (in 1818, 17,601, Parl. Papers 1818, xvi.; in 1821, 17,329, Parl. Papers, 1821, iv.), of course the majority of roads were not under such trusts, other roads being given in 1818 at 86,116 miles."

which he was proceeding to build farm houses and buildings. For the first few years after enclosure all the cultivators, except the farmer of the old demesne, probably continued to live in the village and go daily to their new fields. But with the gradual formation of larger farms, involving a considerable household working at one centre, there was a movement to secure a residence on the holding itself, and as fast as landlords could find capital for building farm houses the exodus from the village high streets took place. It is important to notice that holdings of less than about 40 acres in area were generally located as near the village site as possible. With the formation of larger farms many of the objections to isolated residence disappeared because there was usually a larger family and several relatives and hired labourers living on the farmstead. These numbers gave increased security, and a sufficient degree of social intercourse, if supplemented by visits once or twice a week to the village or market town. During the first three-quarters of the nineteenth century the movement for increasing the size of farms seems to have continued in England, two or three small farms of fifty to one hundred acres being thrown together and let as one. One of the farm houses and appurtenant holdings would be greatly enlarged, and those of the other holdings be dismantled, or be let as residences with garden and paddock if anywhere near a town.

It is worth noting that a vast improvement in the intelligence and class of youths who remain to work on farms in England has occurred during the past 15 years by the cheapening of the bicycle whereby they can meet daily in the evening in the village. It is not difficult to imagine how, in rural India, social life would be raised to an altogether higher plane, were the holdings to be sufficiently enlarged and methods of cultivation improved so that the majority of villagers could afford to own bicycles, and if inter-village roads were all metalled so that they could use them. The Indian villager is fond enough of gadding about if he gets the opportunity ; and it is difficult to overestimate the educational value of local as well as distant travel. Nothing would more rapidly diffuse an interest in and knowledge of improved methods of cultivation.

Mr. Moreland's Note.

In his note referred to above, Mr. Moreland first indicates the advantages which would accrue from a re-distribution of holdings; and then rightly points out that the present waste of power becomes more serious as the cost of production increases. He regards it as desirable that experiments should be made in villages where conditions are favourable, and proceeds to outline a method of proceeding by arranging exchanges of fields. He then suggests that if it were "found possible to make the bulk of the holdings in a village fairly compact," the question of moving homesteads out would arise. "Where the holding is at a long distance from the village, the cultivator might decide after discussion to build a house on it." He next refers to the necessity of retaining the uneconomic holding (in due proportion) as a ladder by which the best and thriftiest labourers can mount to the rank of cultivator. The next paragraph is important: if the result of experiments as above indicated should be negative, the question would then arise of passing an Enclosure Act giving landholders the power to override the opposition of a minority and reorganize their villages with a clear course open. Finally he deals with the question of increasing the size of holdings.

The criticism of this last section of the note relating to the size of holdings must depend entirely on the critic's premises. Mr. Moreland writes as if looking at the question from what I hope I may call the old-fashioned point of view. The question with him is whether external economic forces will force attention to the size of holdings as a serious social evil through the margin between price and cost of production becoming less than a subsistence minimum. He thinks there is no reason for immediate anxiety, and hails the co-operative movement, especially co-operative purchasing and marketing, as a means of at least staving off, if it cannot permanently prevent, such a calamity.

Objects of proposed changes.

My own object in the proposals which I shall make in the remainder of this paper is a very different one from that which may be inferred from Mr. Moreland's note; and I would submit that it

is of fundamental importance to have clearly in view the object of any proposed measures before judging them, and that it is always necessary to decide definitely upon the aim of any reform under consideration before proceeding to discuss what changes are needed and how they are to be carried into effect.

In the measures which I shall now tentatively outline I keep constantly in view as their object the deliberate and progressive increase of the welfare of the Indian people.

The economist is directly concerned with two ways of realizing this end :—

(1) By the development of the economic resources of India with the utmost rapidity consistent with safety in assuring permanence of the results obtained.

(2) By the provision of the physical basis for progress to a higher standard of life—intellectual, religious, moral, and social—by indicating—

(*a*) how to utilize for this purpose with the greatest efficiency the wealth produced by the development of resources ;

(*b*) how the material environment, as regards dwellings, towns, roads, water-supply, public works, and so forth, may be arranged so as to react with the greatest effect in the desired direction of intellectual, moral and social uplift.

There can be no question but that the right line of advance in developing the resources of India is to utilize the machinery of Government in order so to rearrange the land tenure system as to enable the existing body of skill and knowledge of the agricultural art possessed by the cultivators through tradition and by numerous trained experts, and the existing supply of capital in both private and State control, to be employed with the maximum of efficiency in the production of wealth. At the same time in devising measures to this end care should be taken that there is not a serious loss of character and other beneficial qualities of the agricultural population by the social revolution that must be caused, but rather that the measures taken for the production of wealth tend at the same time

to the upbuilding of the more perfect man. As a step in this direction I proceed now to define the type of rural community which appears to me to be a realizable ideal for the near future, and a very distinct advance along the road which I have indicated.

I would like to say at the outset that my views on this question were only formed after a visit last year to the Lower Chenab and Lower Bari Doab canal colonies. I very much doubt whether any one who is not familiar with the wonderful canal colonies of the Punjab will have the faith that has been born in me as to the possibility of the rural regeneration of the rest of British India. In the remainder of this paper I shall refer only to temporarily settled tracts where zemindari system of landlord and tenant prevails as in the provinces of Agra and Oudh, the Central Provinces and parts of the Punjab. Much that I say will also be applicable to the permanently settled territories of the United Provinces, Bihar, and Bengal.

(*To be continued.*)

BLAST OF PADDY.

BY

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In Papanasam Taluk of Tanjore District in the Madras Presidency there was a marked shortage of this year's second crop of the variety of paddy (*Oryza sativa*) called Korangu Samba. The cultivators attributed the short crop to unwonted rain at the end of December when the plants were in flower, but this is an afterthought remembered at harvest-time to explain the shortness.

As an example of how small the crop has been in particular fields the information got in the village of Umaiyālpūram is interesting. Last year as a second-crop paddy Korangu Samba gave 1,008 Madras measures* per acre. This year one acre gave 720 M.m., of which 96 M.m. remained after winnowing. Another field of $1\frac{1}{3}$ acres gave 192 M.m., of which 20 remained after winnowing, *i.e.*, 15 M.m. per acre.

A ten-cent plot in a badly infected field in the village of Umbalapadi was harvested and winnowed in my presence. The yield consisted of $3\frac{3}{4}$ M.m. weighing 308 tolas (almost 8 lb.), *i.e.*, at the rate of $37\frac{1}{2}$ M.m. per acre. The owner said that the usual yield in a ten-cent plot on this land was 120 M.m. and the Tahsildar told me that the average for the taluk was 72 M.m. Before I arrived, most of the paddy had been harvested, and of what still remained on the ground this field was by far the worst I saw. Accordingly, though this experiment shows how great the loss can be, yet from it no estimate can legitimately be made of the loss over any large area and such an estimate I had no means of making, though figures

* One Madras measure contains 108 cubic inches, and one M.m. of paddy weighs $2\frac{1}{2}$ lb.

given me by the Tahsildar from the village officers' reports show that over an area of 1,687 acres in twelve villages the average yield of Korangu Samba was 216 M.m. per acre. In these villages, too, about 428 acres of this variety were sown as first crop, three-quarters of which were in two villages. The yield varied from 36 to 720 M.m. per acre, the average being about 264 M.m. This shows that there was considerable shortage in the first crop this year. Outside these villages there does not seem to have been much talk of short crop and the variety is said not to be widely grown in the taluk as a second-crop paddy.

Perhaps one can get a more impressive idea of the loss caused if it be given in money value on the basis of 12 M.m. to the rupee which was the price after harvest in February. In the two examples from the village of Umaiyālpūram given above, the shortage is $1{,}008-96=912$, and $1{,}008-15=993$ M.m. respectively, or Rs. 76 and Rs. 82 per acre. In the field from which the ten-cent plot was chosen the shortage is $1{,}200-37\frac{1}{2}=1{,}162\frac{1}{2}$ M.m., or Rs. 97 per acre. For the 1,685 acres the loss is $1{,}008-216=792$ M.m., or Rs. 60 per acre, while over the whole area it is 1,336,104 M.m., or Rs. 1,11,000. This is a very great loss indeed and bears out Metcalf's[1] expression that "from the standpoint of the amount of loss it causes it undoubtedly ranks with the grain rusts as one of the most serious plant diseases of the world."

According to the villagers, Korangu Samba was first tried as second-crop paddy in Ganapathi Agrahāram and was brought in 1915 from a village about 25 miles south, where it was grown as a single-crop paddy. The 1915-16 crop in the new conditions was a very good one. Being well spoken of it was tried on a larger scale next year and the crop was again good, being 960 to 1,680 M.m. per acre. This year, however, it has caused much disappointment. To some other villages it was introduced in 1916 from a village where also it was grown as a single-crop paddy. The first year's crop was a heavy one but this year it is very poor. Both these places of origin are outside the irrigated part of the Cauvery delta and the

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[1] Metcalf, H., on pp. 99-105 of *The Diseases of Tropical Plants*, by M. T. Cook, 1913.

soils are higher and more freely drained. This would naturally lead to a deeper rooting habit in the plant and this may account for the high yields which this variety gave in the first one of two crops after being introduced to the heavy soil conditions of the delta lands, though the variety seems not to have been able to adapt itself permanently to those conditions after it had lost its initial vigour. Several people have declared that they will not grow this variety again. There is little likelihood of its being used in these villages and a note of warning has been given to ryots generally in the delta to avoid this variety in future on double-crop land.

Characters of the disease.

Small spots appear on the leaves and extend through the tissues of the leaf, appearing equally on both upper and lower surfaces. Reddish or brownish at first, the centre soon becomes pale yellow. The spots extend more rapidly in the longitudinal direction and may become one inch long by one-fourth inch broad. By this time the edge of the spot becomes pale brown, and ultimately the whole area of the spot becomes brown. Adjacent spots coalesce. The brown areas sometimes extend along nearly the whole of one side of the leaf-blade or they may extend across it and the leaf gradually withers. The central part of the spot assumes a soiled, smoky appearance owing to the presence of the sporophores and spores in abundance, and this occurs on both surfaces of the leaf. Spots are found on the leaf-sheath as well as on the leaf-blade, and may also involve the ligule. When a spot is present at the junction of the blade and the sheath this part often becomes very dark brown. When that part of the leaf-sheath immediately outside a node is infected the stem below it is sometimes infected too, becoming almost black at the node and for a short distance above or below it or both. The stem sometimes bends over at this infected node. When the leaf that encloses the ear-head is infected some of the glumes touching the spots become dark brown and the region of the stem below the ear-head becomes brown and ultimately almost black for a distance of about one inch. This discoloration also extends upwards into the lowest branches of the ear-head. Not

infrequently the stem collapses and breaks at this place and the ear-head hangs downwards. Apart from a few dark brown glumes the ear-heads usually look quite normal, yet the ears are seldom filled. They either have no rice-grains or very stunted grains though some of them may be filled normally. From the ten-cent plot in a badly-infected field in the village of Umaiyālpūram mentioned above, the grains of fifty ear-heads that had a dark discoloration on the stalk just below the ear-head but that looked otherwise normal were counted. There were 7,275 paddy-grains, of which 171 were full and these were found on nine ear-heads, *i.e.*, 2·3 per cent. of the grains contained rice-grains. Of the others a remnant of a rice-grain was present in each paddy-grain, but it was of no use as rice. In many cases, the people had no suspicion that the plants were abnormal and they expected a good yield. It was only when the coolies, paid in kind for their first day's work, complained that they got no rice from the paddy that the owners realized that their crop was short.

A considerable number of plants appear to have been attacked while in quite a young stage. The earliest formed leaves were covered with spots and were dried up as also were most of the later formed leaves. The plants were only about one foot high. They had very few stems with ear-heads and even these contained only empty grains. In other plants the main tillers had matured and there was a considerable amount of secondary growth of branches from them. The ear-heads of the latter showed arrested development and in many cases their branches were not expanded, but had remained together as they were in the stage when they protruded from the sheath. The ears very seldom contained rice-grains. These young branches as they were in all stages of development showed well the various stages of the attack. When a young branch had been attacked early, *i.e.*, before the ear-head had come out of its sheathing leaf, the leaves had numerous spots and were dried up and the ears were empty. The empty ear-heads stand erect and are conspicuous in the field when the normally matured ear-heads all bend over with the weight of the grain. When a branch had been attacked later, the spots occupied a small proportion of the leaf-surface and the ear-heads were comparatively well

filled, though some contained stunted half-formed rice-grains. On the other hand, some plants lightly attacked had well-filled ears. Thus a plant attacked in an early stage suffers worst while one attacked at a late stage of its development is but slightly affected.

In the early stage of the attack these characters are usually fairly definite, but as the general health of the plant becomes affected and it loses its green colour, the colouring of the diseased part becomes indistinct and the presence of the fungus is not easily recognized on the blackened, faded and discoloured leaves and stems which become invaded by various saprophytic fungi.

The characters of the disease found on Korangu Samba were also seen to a small extent on Kārun Kuruvai, Chinna Sirumani, Vellai Sirumani, Thōga Samba and Tanga Samba though not on Tillai Samba, but there is no complaint of short crop on any of these. Two plants of Chinna Sirumani were found in the field from which the ten-cent plot was chosen but they did not have the disease.

The fungus *Piricularia oryzæ* was found on the spots on all positions in which they were found on the plant, *viz.*, leaf, node, stem, ear-head and glumes, and in all the varieties noted. Its hyphæ penetrated the cells of the various tissues and were found in abundance. The sporophores protruded in groups of two to four from the stomata and nearly every stoma on a spot had its quota. The spores were formed singly at the end of the sporophore. When one spore is shed the sporophore grows a little and produces another and five may be produced in all, though in culture 17 have been formed on one sporophore. When looked at through a lens the surface of the spot appeared to be covered with a brown delicate network, which consisted of sporophores and spores. The spore is pale yellow and pear-shaped, and at the broad end is a slight protuberance that attached it to the sporophore. Each spore has two cross walls dividing it into three cells. They germinate readily in water. Two hours after immersion they begin to germinate, and in eighteen hours have produced long branching hyphæ sometimes with spherical resting spores with slightly thickened walls and dense protoplasmic contents. Metcalf says that the three-celled spores

rarely survive over three months, but that the resting spores may survive at least twenty months. There is thus ample opportunity for the fungus to live over the dry weather and infect the next crop.

The fungus has been declared to be the cause of Brusone in Italy by Cavara and Farnetti, of rice-blast in the United States of America by Metcalf and Foulton, and of Imotsi in Japan by Kawakami. In these countries it has done a very great deal of damage.

Seeing that paddy as it is grown is not adaptable to ordinary preventive measures like spraying, any method of control of the disease will have to be along cultural and selective lines. There seems to be a consensus of opinion among those who have investigated the disease that nitrogenous fertilizers render varieties of paddy more susceptible to the disease and this will have to be studied under the local conditions in Tanjore. The success that has attended the production of resistant varieties in other countries, especially Italy, is encouraging, if the disease becomes a menace to paddy cultivation in this country.

EXHIBITS OF THE GOVERNMENT AGRICULTURAL CHEMIST, MADRAS, AT THE MADRAS INDUSTRIAL EXHIBITION, DECEMBER, 1917.

BY

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A CIRCULAR was received from the Director of Agriculture, Madras, on 15th August, 1917, stating that an industrial exhibition would be held at Madras during Christmas, the main object of which was to encourage the manufacture in this country of articles hitherto imported, and the Government Agricultural Chemist was specially asked "to make endeavours to show articles of food prepared from local agricultural produce which could replace similar imported articles." The ordinary departmental work was at once stopped and the whole of the staff turned their energies on to this problem.

So far as food products were concerned, it was felt that the primary problem was the production of a good malt and malt extract, as these are important constituents of many patent foods. The scope of the work was extended so as to include other substances than foodstuffs and the articles finally prepared for the exhibition may be classified as follows:—

A. Infant and invalid foods.
B. Breakfast and other foods.
C. Flours and starches.
D. Beverages.
E. Casein and casein products.
F. Miscellaneous.

A. Infant and invalid foods.

The search for a grain of good malting capacity. Malted foods claimed first attention in the laboratory. As barley, which is the cereal grain almost universally used as the base for the preparation of different malted foods, is grown only to a small extent in Madras, a substitute for barley was sought for amongst the important cereal grains of the Presidency, *viz.*, paddy (*Oryza sativa*), *cholam* (*Sorghum vulgare*), *ragi* (*Eleusine coracana*), *cumbu* (spiked millet) and *tenai* (*Setaria italica*).* These grains were each malted and their diastatic activity determined and compared; the experiments showed that *cholam* and *ragi* malted as well as barley. The malting process was carried out in the following manner :—

A quantity of each kind of grain was soaked in water for 24 hours, drained and spread in large tin trays to germinate, the trays being covered with a wet cloth to preserve a moist atmosphere. After three to five days when the radicles were prominently visible and had attained a length of about ½ inch, germination was arrested by first drying in the shade for two days on the stone floor of the verandahs and then in the sun for one day, after which the malted grain was ground in a laboratory sampling mill.

The diastatic activity of each malted meal was determined as follows :—

Fifteen grams of the malt were digested with 250 c.c. of water at room temperature (average 28°C.) for four hours. The extract was filtered, the first portions being rejected. One c.c. of the filtrate was added to 15 c.c. of a 2 per cent. solution of soluble starch, and, at the end of one hour, the starch solution was tested with iodine. In the case of *cholam* and *ragi* no starch remained, but in the case of others starch was present and had not been

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* According to the Agricultural Statistics of the Madras Presidency for 1916-17, the normal acreages of the above crops were :—

	Acres
Paddy	10,687,950
Cholam	5,407,450
Ragi	2,502,350
Cumbu	3,509,120
Barley	3,120

completely hydrolysed even after twelve hours, thereby indicating that *cholam* and *ragi* malted better than paddy, *cumbu*, maize, or *tenai*. Preliminary experiments showed that *cholam* and *ragi* were a little superior to barley in diastatic activity as shown by colour reactions with iodine. Further investigations regarding the differences in diastatic activity of barley, *cholam* and *ragi* and of the sugars formed by hydrolysis therefrom have been carried out and submitted for publication as a memoir in the chemical series.[1]

The malted *cholam* and *ragi* thus prepared were utilized for the preparation of several types of patent foods.

Benger's food type. The coarsely ground *cholam* and *ragi* malts were sieved in a 100-mesh sieve to remove husk, mixed separately with arrowroot starch in the proportion of 3 to 1 and bottled air-tight. Thus were obtained two substitutes for Benger's food, one from *cholam* and another from *ragi.* The prepared foods had the same properties as Benger's and, when prepared according to the directions given on the Benger's food bottle, were found to have all their starch hydrolysed.

Malt extract. Four hundred grams of *cholam* and *ragi* malts were each extracted with 1,200 c.c. of water at room temperature for three hours, filtered through muslin, clarified with kaolin and filtered, and the liquor evaporated *in vacuo* at a temperature of 40–50°C. and at a pressure of about 50 m.m. so as to prevent the destruction of the diastase. While the evaporation of the diastatic liquor was proceeding, the residue on the muslin was transferred to a large flask with water and quickly raised to boiling, whereby the starch became gelatinized and the proteids coagulated. This gelatinized starch solution was filtered through a percolator and added gradually to the evaporating malt liquor, so that hydrolysis of starch took place simultaneously with the evaporation of the liquid. As soon as the contents of the distilling flask became sufficiently thick which usually took from 12 to 15 hours in the improvised apparatus, the malt extract was poured out into stoppered bottles. The

[1] Memoir vol. V, no. 4 of the Chemical Series, by B. Viswanath, T. Lakshmana Raw and P. A. Raghunathaswami Ayyangar. (*In the press.*)

specific gravity of the extract thus obtained was 1·30 and, in order to imitate the colour and the caramel odour of the imported article, baked starch was added in some cases during the evaporation process. Malt extracts prepared from both *cholam* and *ragi* have kept well for over six months.

Mellin's food type. To the diastatic liquor referred to in the preceding paragraph, gelatinized starch solution was added in the proportion of 1 of malt liquor to 2 of starch solution and the whole evaporated *in vacuo*. The residue was dried *in vacuo* and then powdered with some lactose, forming a satisfactory substitute for Mellin's food.

Horlick's malted milk type. Partially skimmed milk containing 1 per cent. of fat was evaporated and dried *in vacuo* at 50°C. The dry residue was powdered, mixed with desiccated malt extract (*i.e.*, Mellin's food) and sodium bicarbonate in the proportion of 69 : 30 : 1 and quickly bottled.

Sanatogen, Plasmon, and Eucasein types. Casein being the chief proteid material in milk and possessing good keeping qualities, if carefully prepared and stored dry, several patent foods have been prepared from casein and placed from time to time on the market under different trade names, *viz.*, Lactarine, Guttman's nutrient milk powder, Sanatogen, Eulactol, Eucasein, Plasmon, Dr. Reigl's milk albumen, etc. Carefully prepared dry casein is tasteless and odourless, somewhat resembling flour and is easily assimilable. The processes of manufacture of several of these different patent foods are not known with certainty and the methods detailed here merely represent attempts made by the staff to prepare some of them.

For the above foods, casein was precipitated from skimmed milk containing very little fat by curdling with sulphuric acid and purified by squeezing the whey, redissolving the curd in slight excess of ammonia and reprecipitating with slight excess of acetic acid. The purified casein was well washed with water, passed through a screw-press to remove water, dried at 70°C., ground to a powder and bottled.

A substitute for Sanatogen was obtained by dissolving the casein in sodium glycerophosphate, evaporating the viscous mass

to dryness *in vacuo* and reducing the dried mass to powder. The product is soluble in water.

A substitute for Eucasein was prepared by passing ammonia through casein suspended in alcohol and afterwards separating and drying the casein. This ammoniated casein is soluble in water.

A substitute for Plasmon was made by mixing together 80 parts of casein containing about 5 per cent. of fat, 7 parts of sodium bicarbonate and 13 parts of lactose. It is partly soluble in water.

These three casein food products prepared in the laboratory were found to resemble the respective patent foods in colour, solubility and taste.

Nutrose. Groundnut cake is a rich nitrogenous material containing 45 to 50 per cent. of proteids, and is used in the country either as cattle food or as manure. With slight manipulation, it can be converted into a suitable human food and this has already been done in the highly advertised German food Nutrose.[1] Proteids are made up of a number of amino-compounds but the proteids of groundnut cake are deficient in one of them, tryptophane. This is rectified by the addition of dried milk, casein or wheat flour.

Good, well-pressed groundnut cake obtained from the Deputy Director of Agriculture, IV Circle, was ground and 94 parts of the meal mixed with 5 parts of casein and 1 part of sodium bicarbonate, the resulting product being similar to Nutrose. Nutrose is a valuable invalid food, chiefly for diabetic patients of whom there are only too many in India.

If 3 parts of wheat flour are mixed with 1 part of Nutrose, the resulting flour can be made into excellent bread, much superior in nutritive quality and taste to pure wheaten bread.

B. Breakfast and other foods.

Cheese. Good samples of cheese of the Cheddar kind were prepared successfully, notwithstanding climatic difficulties, by two methods—(1) by the addition of rennet, and (2) by sour milk. The

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[1] *The Agricultural Journal of India*, vol. XIII, part II, April, 1918, pp. 351–355.

cheeses were highly appreciated at the exhibition and pronounced to be excellent.

Grape nuts. An attempt was made to reproduce this highly appreciated American food in the following manner. A hundred parts of *cholam* or *ragi* malt were added to 400 parts of wheat flour, and water was added so as to produce a mass of a thick consistency. This was left for four hours so that as much wheat as possible might be digested by the malt. Three hundred parts more of malt were then added and the whole worked into a dough, together with some yeast, kept an hour to ferment and baked in a hot-air oven at 200°C. for about an hour. The baked bread was next cut into thin slices, dried in the draught oven, coarsely pestled in a mortar and sieved to proper grains.

Shredded wheat. Flour milled from well-husked wheat was cooked in steam for two hours. After cooling, a mixture of tartaric acid and sodium bicarbonate, in the proportion of 4 : 6 to 100 of wheat flour, was prepared and the mass was pressed through a die in a screwpress and the issuing shreds collected and rolled gently to resemble the imported article and then baked in the oven until dry and crisp.

Vermicelli and macaroni. Fine wheat rolong was mixed with sufficient water and kneaded into a dough which was then passed through improvised dies in the screwpress. The shreds of vermicelli and the tubular macaroni issuing from the dies were dried in the shade and packed.

Desiccated coconuts. Desiccated coconut is finding increasing application in the preparation of confectionery, sweets, etc., and a number of large factories are run in America for desiccating coconuts. Coconuts are plentiful in this country and the principle of manufacture of desiccated nut is quite simple. Coconuts of medium ripeness were scraped in the household coconut-scraper, spread in thin layers in a draught oven, dried and secured in air-tight bottles, the preserved coconut forming a crisp material. This was much appreciated at the exhibition.

Candied peel. Healthy skins of oranges and lemons, with their inner placenta removed, were boiled in water until they became

soft and the water was drained off. Concentrated thick syrup of cane sugar was prepared and the boiled orange and lemon skins were suspended in the same until they became translucent. The peel was then removed, dried and once again treated with boiling syrup of proper consistency, and stirred until the candied peel nearly set, after which it was stored in bottles.

C. Flours and starches.

Soup flours. Pea flour is the one ordinarily used for making soup for European tastes. As peas are only grown to a small extent in the Presidency, whereas several pulse grains are grown in very large areas throughout the country, an attempt was made to prepare soup flours from these pulses as substitutes for pea flour. Healthy grains of red gram or *dholl* (*Cajanus indicus*), Bengal gram (*Cicer arietinum*) and green gram (*Phaseolus mungo*) were dried in the sun and soaked in water, the lighter grains were scooped out and the soaked grains dried and husked in light stone mills. After winnowing, the clean kernels were ground into flour in a heavy country stone mill, sieved through a fine mesh sieve, dried in the steam oven and put in bottles. The flours have kept well for over six months and have been pronounced, after actual use in cooking on a number of occasions, to be as good as pea flour for making soup.

Starches. Pure white starches are in very great demand in the country, chiefly for textile fabrics. *Cholam, ragi* and sweet potatoes were manipulated in the following manner for making starches :—

Cholam and *ragi* grains were separately soaked in 0·3 per cent. caustic soda for 24 hours, washed free from alkali, dried in the sun and ground into flour. The flour was now soaked in 0·15 per cent. caustic soda for another 24 hours, the supernatant liquid was siphoned off and the starches were well washed until free from alkali, and the fine starch granules were separated by sedimentation, dried in the sun and stored.

In the case of sweet potatoes, well-washed tubers were scraped on the surface to remove the brown thin skin, ground in a mortar

to a soft pulp and mixed with water. The starch granules were separated by sedimentation and dried.

All the three starches were fairly pure and analysed as follows :—

Samples	Pure starch	Moisture at 100°C.
Starch from cholam	84·92	8·79
,, ragi	84·79	10·63
,, sweet potatoes	85·20	9·69

D. Beverages.

Lime juice cordial. The juice of lime fruits was clarified with kaolin, sweetened and sterilized. This refreshing drink has kept well for six months without undergoing fermentation.

Cholam beer. Four thousand grams of malted *cholam* were ground into a meal, mixed with 15 litres of water, to which 5 grams of $CaSO_4$ were added and the whole was maintained at 65° to 70°C. with continuous stirring for three hours, by which time it was found, by testing with iodine, that all the starch had been hydrolysed. The liquid was quickly raised to the boiling point at which it was kept for an hour, 20 grams of tannin and 100 grams of bitter gourd powder having previously been added. To some of the samples 2 oz. of hops were added. The mash liquor was filtered, cooled quickly in running water, diluted to a specific gravity of 1·050 and transferred to glazed pots such as are used in the pot culture house. Baker's yeast was added to a small quantity of the mash liquor to start fermentation and this was added, after six hours, to the liquid, in the pot. The rate of fermentation was tested by specific gravity which gradually went down to 1·025 in 24 hours and then remained stationary. The liquid was poured into beer bottles and corked secure. There was no attempt made at pasteurization for want of suitable apparatus. The beer was tolerably good for a first attempt.

E. Casein and casein products.

Casein. Skim milk (cows' or buffaloes') from a cream separator was used for the preparation of casein. While the coagulation of milk can be effected by several methods, *e.g.*, by the addition of

sulphuric acid, rennet or sour milk, precipitation by sulphuric acid was found most convenient and was effected by mixing $1\frac{1}{2}$ parts by volume of strong sulphuric acid with 7 parts of water and adding the mixture to 1,000 volumes of milk. The precipitated casein was washed and dried and formed the base for the manufacture of a number of products.

Caseïn paints and distempers. Casein dissolves in solutions of the hydroxides of alkali and alkaline earth metals, being less soluble in the latter. The casein-lime compound, however, has the power of absorbing carbonic acid from the air and becoming insoluble, and it is this property which is utilized in the making of casein paints and distempers. These consist of mixtures of casein and slaked lime with suitable pigments. On the addition of water, the casein and lime combine to form a sticky soluble product holding the pigment in suspension. When spread as a thin layer with a brush on any surface—wall, timber or iron—it absorbs carbonic acid from the air becoming an insoluble durable coating which holds within itself the particles of the pigment. When applied to walls, the paint enters into combination with the underlying plaster and becomes increasingly durable.

The proportions of lime to casein and of the lime-casein to the pigment in the mixture are important. Too little lime makes the product insoluble, especially if exposed during storage, and too much lime induces the paint to come off in flakes. Similarly if too little paint be added, the coating is brittle and liable to flake off, and if too much, the paint will dust off and not stand washing. Again, it is only those pigments which are not affected by lime that are suitable for the manufacture of casein paints. These are, for example :—

whiting, zinc oxide and China clay ..	*for white*
ochre, chrome yellow, etc. ..	*for yellow*
raw and burnt sienna and umber ..	*for brown*
soot and carbon blacks	*for black*
red lead	*for red*
ultramarine	*for blue*
green earth, lime green, etc. ..	*for green*

and so on

The recipes for the different paints are slightly different. White paint may be made up of casein 100, slaked lime 100, levigated chalk 800, borax 1 and ultramarine 2 to 3 parts by weight, while the coloured paints may be made from casein 100, slaked lime 100, levigated chalk 400, pigment 400 and borax 1 part. It is important that the ingredients are very finely powdered and thoroughly dried; when stored in tightly closed boxes lined with paper, the mixtures keep indefinitely without losing their properties.

For use, 50 parts of water are added to 100 parts of the powder in a clean vessel and stirred until the mass is homogeneous and free from lumps. The contents are then covered with a thin layer of water and set aside for 45 minutes, after which they are stirred with more water to the consistency of an oil paint. Thus prepared, it should be used without delay as it is liable to set hard in a comparatively short time becoming unfit in twelve hours. Rough surfaces must be painted thinner than smooth ones. As mentioned above, the paint will adhere to any clean surface, such as lime, plaster of Paris, cement, plaster, brick, timber, stone or metal, as well as canvas. It dries quickly with a matte surface and, after 36 to 48 hours, can be washed without fear and will stand the weather. So long as old coatings of lime on walls are removed and the substratum is firm, the casein paints will readily adhere and will not crack or peel off. A glossy paint for indoor use can be produced by spraying the painted surface with a mixture of turpentine and wax and polishing it afterwards.

Casein adhesives. Casein, in solution with caustic alkalis or alkaline salts, has adhesive properties and, as such, has been applied for the preparation of glues and cements which have been placed in the market under various trade names, such as casein-glue, cold glue, caseo-gum, etc. These are suitable for several industrial purposes, especially in wood work, as they are ready for immediate use without previous soaking and heating as with ordinary glue.

For wood, China and glass, 15 to 20 parts of casein are mixed intimately with 1 to 4 parts of borax and sufficient water added with careful stirring, when required for use.

Casein dissolved in a strong solution of borax forms a good, clear adhesive, keeps indefinitely and can replace gum arabic or dextrine. Caustic soda or potash or ammonia could be used instead of borax in making this liquid glue and the addition of a little carbolic acid or thymol prevents any chance of putrefaction.

Casein film.—Casein was tried as a substitute for gelatine in the preparation of photographic paper with good results. Writing paper of good quality was coated with a solution prepared as follows :—

Seventy grams of casein were heated with one litre of water to 50°C., 100 c.c. of a 25 per cent. solution of citric acid added and the mixture stirred until a homogeneous solution was obtained. Twenty grams of glycerine were then added.

The paper which was coated with the above was, after drying in the shade, drawn through a 5 per cent. solution of ammonium chloride to render the casein insoluble, dried and sensitized in the dark room by floating in a 10 per cent. solution of silver nitrate, and again dried in the dark room. Prints were obtained as on ordinary P. O. P., and the operations of toning and fixing were the same as with P. O. P. Several photographs printed on Government lined paper were exhibited.

Shoe and boot polishes. After several trials, the following recipes were found successful :—

Brown polish.—Dissolve 1 part of borax in 20 parts of water, add 5 parts of shellac and warm until dissolved. Add 1½ parts of soap and 2 parts of casein and stir over the water bath until a homogeneous paste is obtained. Now add 2 parts of hard paraffin and incorporate with the paste, and then add gradually, with constant stirring, 30 to 40 parts of turpentine, thinning down with more water as may be found necessary. Finally add enough annato extract to give the required shade of colour.

Black polish.—Dissolve 2 parts of casein in 40 parts of vinegar, add 2 parts of paraffin and heat on the water bath, stirring the while until a pasty mass is obtained. Next add 50 parts of turpentine gradually and stir on the water bath to a uniform paste, adding water as may be necessary, and then incorporate sufficient lamp black into it.

A few drops of nitrobenzene are also added at the end to give an agreeable smell.

F. Miscellaneous.

Lactose or milk sugar. The whey draining from the curd in cheese-making was acidulated with acetic acid and heated on the water bath. The precipitated milk albumen was removed by straining and the evaporation was continued on the water bath until the liquid began to turn brown, after which the concentration was continued *in vacuo* until a syrup was obtained. This was poured in porcelain dishes and allowed to crystallize. When crystallization was complete, the mother liquor was drained off and the crystals were washed with a fine spray of water from which and the mother liquor a second and then a third crop of crystals were similarly obtained. The different crops of crystals were separately redissolved in water, shaken with bone charcoal and filtered. The resulting clear filtrate was concentrated *in vacuo.* In the absence of a centrifugal machine, the final separation of lactose was effected by the addition of alcohol and filtering. From the first crop of crystals a white product was obtained while the other two gave brown coloured crystals of lactose.

Citric acid. Limejuice clarified with kaolin was tested for acidity and the calculated quantity of powdered calcium carbonate added to the boiling juice whereby the calcium citrate was precipitated. The precipitate was washed with boiling water by decantation and the calculated quantity of sulphuric acid (1 of acid diluted with 3 of water) added to the boiling solution, when calcium sulphate was precipitated and the citric acid went into solution. The sulphate was filtered off and the filtrate was evaporated and allowed to crystallize. The crystals were drained from the mother liquor, dissolved again in water, evaporated *in vacuo* and allowed to crystallize. A portion of the crystals was recrystallized by dissolving in water and allowing the water to evaporate slowly at a low temperature.

Tartaric acid. Full grown tamarind pods—not ripe fruits—were crushed in a mortar to a pulp, soaked in water, filtered over

a cloth, boiled with kaolin and filtered under the pump until a clear filtrate was obtained. This was tested for acidity, the calculated quantity of calcium carbonate was added to convert the acid into calcium tartrate and the calculated quantity of sulphuric acid (diluted 1 to 3) then added to the boiling solution, when calcium sulphate was thrown out as a precipitate and filtered off and free tartaric acid left in the filtrate. This was evaporated at a low temperature and allowed to crystallize. The crystals were separated from the mother liquor, redissolved in water and evaporated *in vacuo* and allowed to crystallize.

The two acids, citric and tartaric, prepared as above, are commercial products and cannot be said to be absolutely pure. It is proposed to estimate their exact composition later on.

Papain. Papain is a digestive enzyme acting on the proteids of food and converting them into soluble peptones. In this respect it resembles the pepsin of the gastric juice, but is superior to it in that the latter can act only in an acid medium, while the former can act in acid, alkaline or neutral solutions. The ferment can be easily obtained from the juice of the papaya fruit. Half-ripe papaya fruits, as they stand on the tree, are pricked with a small knife when a milky fluid exudes which soon coagulates to a plastic mass. A fair quantity is thus collected from a number of fruits, the fruits themselves not being spoiled in any way, and then extracted repeatedly with water in which the papain is soluble. The liquid is filtered, evaporated at 50°C. *in vacuo*, and the residue is again dissolved in the smallest quantity of water. The enzyme is now precipitated by the addition of alcohol, filtered, dried at a temperature of 40°C., powdered and stored in bottles.

CONCLUSION.

The Acting Agricultural Chemist and the staff attended the exhibition wherein the Chemist's stall attracted a great deal of attention from all classes of visitors and a number of samples of the exhibits were distributed.

It was a source of satisfaction to the staff that the Chemist's section was awarded one of the few gold medals presented by the

exhibition and also two Diplomas of Excellence—one for "Food Products" and the other for the work of the section in general. While the work done so far in the laboratory at Coimbatore indicates that great possibilities exist for the manufacture of suitable substitutes for articles now imported out of indigenous produce, it has to be borne in mind that the investigations are far from complete and require more concentrated application than possible in the laboratory of an agricultural chemist, wherein a certain amount of routine work on soils and manures has to be got through every year. The commercial possibilities of the manufacture of the above articles cannot be discussed at this stage until actual trials have been made on a larger scale and the investigations are more complete.

LUCERNE: WHY AN IRRIGATED CROP?

BY

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I

ALL the writers on lucerne in this country speak of it as a crop which can only be grown by the aid of irrigation. Certainly in the more arid districts it is impossible to grow it without, but we are told that lucerne is successfully grown in America, unirrigated, in districts having a much smaller rainfall than the averages of the United Provinces and much of Eastern Punjab. Further, of all plants it is, or should be, suited to maintain itself alive in periods of drought, in view of its deep-rooted character.

Lucerne is such a valuable fodder that if it can be grown on unirrigated land, a valuable addition to the stock-carrying capacity of the country will be obtained.

II

Accordingly, trials were decided on, and in the autumn of 1915 a plot, measuring 4·6 acres, was selected on the Cawnpore Government Dairy Farm. The soil is a free-working loam of good quality and fairly well drained; it had been trenched in with bazaar sweepings twelve inches deep in about 1904, but in 1915 the only trace of the trenching was a thin black line about ten inches below the surface.

The plot was in grass, cut annually for hay, until 1914, and was then sown to *jowar* (*A. Sorghum*) in the summer, and barley in the winter; in 1915, sown to *jowar* in the summer, and in the winter to oats in which 8 lb. of lucerne seed was mixed.

When the oats were cut, lucerne plants were found thinly dotted about. These seemed healthy and strong, and it was decided to put the plot down to lucerne alone the following autumn. In preparation for this, the land was ploughed five times during the summer, a remarkable thing being that the scattered lucerne plants above mentioned were not killed in the process, although iron ploughs were used. No doubt a few died, but the bulk survived.

During the rains it was frequently cultivated to keep down the weeds, and sown on 29th September at the rate of 18 lb. per acre. A very good take resulted, and the crop grew well. Cutting began on the 28th of December and continued daily for issue to the stock, the rate of cutting being regulated by the pace at which the cut plants grew again, so as to have a continuous issue. This continuous cutting was kept up until the 10th of June, 1917, when the total production amounted to 95,014 lb. green lucerne, or 20,655 lb. per acre. At this time the growth had slackened, though it had not entirely ceased.

After the first monsoon rainfall, another cutting was soon ready and removed from 4th July onwards. The fifth cutting was taken in August, and a sixth was ready early in October, but this was made into hay and is not included in the recorded weights. The actual quantity of green lucerne cut in the twelve months from the date of sowing was 149,130 lb., or 32,421 lb. per acre. It was estimated that, with the October cutting made into hay, which was ready within twelve months from the first *cutting*, the outturn of green lucerne, per acre, was about 39,000 lb.

After each cutting the land was harrowed, the first time very lightly, but increasing in depth after each cutting until at the fourth time the harrows were run two to three inches deep. Seven-tine spring-toothed harrows were used and they kept the land thoroughly clean.

The outturn is less good than it might have been, had not "dodder" appeared in two or three patches in April 1917. We were advised to plough up the whole field, but by *cheeling* (scraping) the patches we were able to get rid of the pest, and then, in the autumn, resowed them.

In the winter and spring of 1917-18 the plant grew practically as well as in the year before, but the measures adopted to eradicate "dodder" reduced the outturn.

In both years the land was given a light dressing of rotted cattle manure, which no doubt helped the plants to some extent; but the important point is the ability of lucerne to establish itself and grow during eight months of practically rainless weather. This it has done now for two years in succession, or three years if the light seeding of 1915 is counted.

The rainfall, outside the monsoon season, has been as follows:—

1st October, 1916, to 1st June, 1917	..	7·04 inches.
1st „ 1917, to 1st „ 1918	..	4·84 „

As the results at Cawnpore, however, were likely to have been aided by the moisture-retaining properties of the old trenching in of bazaar rubbish, it was decided to make a concurrent trial on land having characteristics exceptionally unfavourable to conservation of moisture.

At Karnal a plot was prepared on the edge of a ravine, one of the poorest pieces of soil on the whole farm and exceptionally dry. This was sown in the autumn of 1916 also. The seed germinated well and in April of this year (1918) the plants were still alive and healthy, but the rate of growth has been slow throughout. This plot is in the middle of a grazing field and the cattle have grazed the lucerne with the grass, so no record of outturn has been kept. The only object was to discover if lucerne would remain alive under such conditions and this it has done. It should be stated, however, that the seed in this case was not ordinary Indian lucerne but a variety obtained from the United States called "Montana Dry Land Alfalfa."

Still another trial has been made since at Ambala, a plot of about one acre being sown down in the autumn of 1917. It was cut three times in the following winter and spring, and a fourth crop was kept for seed and harvested in June.

The rainfall at Ambala from 1st October, 1917, to 1st June, 1918, was 10·83 inches.

III

The trials, and our observations during their progress, go to show that unirrigated lucerne can be established successfully on most soils of the Gangetic plain, and that where there is sufficient moisture in the subsoil it will give a highly remunerative outturn throughout the winter and early summer, if the soil is of good quality and well drained.

The outturn will not, however, be quite as much as would be obtained from the same land under irrigation; on the other hand, the percentage of dry matter in the green lucerne is believed to be substantially higher when the plant is grown naturally than when forced by irrigation in a heated atmosphere.

The Cawnpore plant was not very high at any time, but the Ambala specimen was fully up to what would be called a good crop on irrigated land.

The rate of growth between cuttings was clearly and increasingly slower than it would have been under irrigation as the summer advanced, but it was steady and continuous till well on in June at both stations, which is very remarkable.

Another point to notice is that the unirrigated lucerne withstands the monsoon much better than the irrigated, and grows as naturally as at any other time. All the writer's experience of irrigated lucerne is that it gets sickly and practically stops growing in the rains. The reason no doubt is that the irrigated soil is already saturated underneath when the rains come and lucerne cannot withstand the consequent water-logging.

The general result of the trials appears to have a wider application than the military farms.

Two main limitations on the productive capacity of the average cultivated holding are—

(*a*) shortage of cultivating power—in other words, lack of fodder for cattle;

(*b*) lack of soil moisture.

With irrigation allowed on, say, one-third of his total area, the cultivator cannot be expected to devote irrigated land to any but "money" crops.

On the unirrigated land, he can spare a very small area for fodder crops in the *kharif* (monsoon cropping), and he has a certain amount of stalks and straw as by-products both then and in the *rabi* (winter cropping), but the total is far too little.

Advice to grow special fodder crops, such as berseem, for instance, which must be irrigated copiously, naturally finds him unresponsive.

As to *barani* fodder crops, in winter the soil moisture is never sufficient to give a heavy yield, and though a man may be driven to sacrificing a patch of his wheat to tide over a month of scarcity, he is fully alive to its wastefulness and the loss of money he incurs.

Lastly, as we know, the fodders usually produced, *jowar* stalks, *bhusa* and the like, are most innutritious, and if they are to do more than just keep cattle alive must be supplemented by oilcake, etc., at substantial expense.

If therefore we can find a crop which—

(*a*) need not be irrigated,

(*b*) will grow at that season of the year (January to June) when fodder is scarcest,

(*c*) has high food value itself and hence requires little, if any, supplement in the form of concentrates,

(*d*) produces a greater total weight in twelve months than other fodder crops,

(*e*) once sown stands for two or more years, and so saves renewed preparation of the soil and purchase of seed,

a substantial economy must result from its use.

If, in addition, the crop is one which need not displace any other but rather takes the place of the fallow, and this I think can be claimed for lucerne in most cases, there is a clear gain in the total productive capacity of a given area.

It is not suggested that there is anything new about lucerne but it seems possible that we have overlooked its greatest value, namely,

ability to obtain moisture in situations where no other fodder plant can.

The success of the trial at Cawnpore was mainly due to the very thorough and painstaking work of Mr. B. J. Newman, then Manager of the Government Dairy Farm there. The whole idea was as much his as the writer's.

THE TRUE SPHERE OF CENTRAL CO-OPERATIVE BANKS.

BY

N. K. KELKAR,

Governor of the Co-operative Federation, Central Provinces and Berar.

"If the foot shall say Because I am not the hand
" I am not of the body ; is it therefore not of the body ?"

THE July (1918) issue of the *Agricultural Journal of India* (vol. XIII, pt. III) contains an article from the pen of Mr. R. B. Ewbank on "The True Sphere of Central Co-operative Banks." It is stated that in the last few years there has been a distinct tendency, most marked in the Central Provinces, the United Provinces, and Bihar and Orissa, to make the District Central Bank the pivot of co-operative administration. The arguments are based mainly on theoretical grounds but reference is made to the practice adopted in the United Provinces, and it is implied that the practice adopted in those provinces is typical of the system adopted in the other provinces mentioned. A very copious extract is given from Mr. Willoughby's last (1916-17) Administration Report for the United Provinces. As I shall have occasion to refer to this extract it will bear quoting again at length.

"The system to which we are committed in this province entrusts the finance, supervision and indeed the whole fortune of the movement to the District and Central Banks. These banks are administered by Boards of Directors who are predominately urban and professional. Such bodies are by their constitution ill-adapted to establish the intimate contact required for the fostering and training of such a delicate plant as the young village credit society, or even for its control or finance when adult. The lawyer, banker,

and other professional gentlemen can hardly be expected to find time constantly to visit villages, often distant, and to find out what their staff is doing there. They are inevitably dependent on their paid staff. Now no committee of townsfolk can lend money with advantage or safety to a multitude of individual rustics whom they have never seen and never met and whose credit they cannot gauge through a staff whom they cannot check or control. The attempt is apt to result in the mere substitution of the urban middle class for the village money-lender as the usurer without advantage to either lender or borrower. For with an uncontrolled staff the effective rate of interest really paid tends to be quite as high as the bania's. . . . . Experience has continued to show that too many central societies regard their primaries rather as customers to be bled than as children to be fed."

It is noticeable that if this indictment of the system of control by Central Banks is accepted at its face value it would prove very much more than Mr. Ewbank would accept. For it would indicate not only that Central Banks are incapable of undertaking the audit, training, organization, etc., of primary societies, but also that Central Banks are incapable of performing with safety to their shareholders and with advantage to their primary societies those financial functions which Mr. Ewbank claims to be their sole *raison d'etre.* Indeed no system of Central Banks which "cannot lend money with advantage or safety to individual rustics whom they have never seen and never met and whose credit they cannot gauge through a staff whom they cannot check or control," would be a safe foundation on which to base that organization of central finance which Mr. Ewbank deems to be most desirable. It is worth while therefore to consider whether the system described by Mr. Ewbank is the system which is in force in those other provinces to which he alludes. So far as the Central Provinces are concerned it may be at once stated that the Central Bank is not the pivot of co-operative administration, and that neither control of audit, training, organization or propaganda is entrusted to it. The pivot of co-operative administration in the Central Provinces is the Co-operative

Federation which consists of all co-operative institutions in the Central Provinces voicing their opinion in the Federation Congress by representatives duly elected on democratic principles. Audit is under the control of the Registrar though the staff is partly paid from Federation funds, but the training, organization and propaganda are under the control of the Federation acting through its local representatives.

There is no little confusion in the use of the term Central Bank as applied to the controlling agency and it seems desirable to understand clearly what is meant when reference is made to control by a Central Bank. The Central Bank is a body corporate. It can advance money because as a body corporate it can hold property. Its Directorate may even pass resolutions on questions of policy. But when we speak of control and supervision of primary societies by a Central Bank we are really guilty of a terminological inexactitude. Primary societies can be supervised and controlled only by individuals. It is quite impossible to think of a Central Bank or even the Directorate of the Central Bank inspecting societies. The question that we must decide therefore is whether in the Central Provinces the Co-operative Federation should entrust the fulfilment of its resolutions to individuals, who are also either members or Directors of the Central Bank.

In his article Mr. Ewbank gives a description of the functions of the Central Bank but nowhere lays down either what its constitution is or what it should be. There is a brief reference of a line or two to the representation of primary societies on the Central Bank Directorate but the subject is not pursued. But clearly the constitution of the Central Bank is of the utmost importance in deciding the relation it should bear to its primary societies, and a discussion of this matter is therefore essential to the proper appreciation of the problem. There are three types of Central Banks. The first type sprang into existence when the necessity for affording financial facilities to the primary societies first made itself felt. The function of this type was, as Mr. Ewbank says, to advance loans to primary societies; it consisted of a small body of individual members having no financial stake in the primary societies who

put up the share capital necessary for the commencement of the business. It is in this sense that the term Central Bank is understood both in Mr. Willoughby's report and Mr. Ewbank's article, and it is against the interference in the affairs of primary societies by the Directors of Central Banks of this type that Mr. Ewbank's warnings are directed. And no doubt what Mr. Ewbank says has very great force in it. For it is obvious that unless the shareholders in a Central Bank are imbued with the true co-operative spirit and unless they are enthusiastic and their higher ideals are aroused, there is a very great danger of interference with the primary societies in the interest of what is commonly known as dividend-hunting. We have had our experience of this type of Central Bank in the Central Provinces, but our experience has been more fortunate than appears to have been the case of the United Provinces. Our Directorates were originally formed of Malguzars, richer agriculturists, pleaders and a small sprinkling of money-lenders. But we have always been able to secure on the Directorate men whose enthusiasm has been aroused and whose work has been disinterested and truly co-operative, and it is to such men that in the commencement the Co-operative Federation entrusted the execution of the policy laid down by it. Our lawyers have found time to visit village societies; in fact in several Central Banks the prominent pleaders have spent every civil court holiday throughout the year on tours of this sort. Our Secretaries of Central Banks have made a point of seeing and discussing village affairs with the societies when they come to Central Banks to take their loans, and even in the first stage of Central Banks it would be incorrect to say that the Board of Directors had been out of touch with primary societies or out of sympathy with their demands and requirements. At the same time so long as there is a possibility of a clash of interests between the individual shareholders of the Central Bank and the primary societies, it cannot be held that the organization is truly co-operative, and it is for this reason that we have advanced in the Central Provinces to the second form of constitution of Central Banks.

In the second stage the societies, having by this time acquired sufficient reserve funds or accumulated profits, are in a position to

take up shares in Central Banks. Inasmuch as the number of societies in these provinces is larger than the individual shareholders the societies have acquired a controlling interest in the banks and the majority of the Directors of the Central Bank are elected from amongst their own members by the primary societies and Circle Unions affiliated to the bank. The primary societies have thus a controlling voice in all questions of policy in the bank (subject of course to the resolutions not conflicting with the resolutions of the Co-operative Federation by which so long as they continue members of the Federation all are bound), and any attempt at selfish interference in the affairs of the societies in the interests of the individual shareholders of the bank would be very quickly suppressed. For it is not true, as some people believe, that the agriculturists are dumb, voiceless individuals. On the contrary, when their interests are concerned they are quick with their suggestions and slow to accept interference even by the more educated shareholders. The third type of Central Banks I need not discuss. It is an ideal to which we hope to attain, when the primary societies' reserves are sufficient to take over the shares now held by individual shareholders both in Central and Provincial Banks. The accomplishment of this will take time, but when we shall have accomplished this we shall have the co-operative movement owned and controlled entirely by primary societies and their representatives.

It will now be apparent that the duties and functions which can be entrusted to the Directors of Central Banks must vary at the different stages of the movement. The functions of a Central Bank, *qua* Bank, are, in Mr. Ewbank's words, to say "yes" or "no" to loan applications, and in so far as a Central Bank approximates in type to an ordinary joint stock bank, in so far as the first consideration is the interest of the shareholders and not the interest of the societies, to that extent it is unsafe to allow the Directors of the Central Bank any part in the education or general supervision of the movement. But when the Central Bank is not merely a bank but a co-operative institution, when the interests of the Central Bank and its constituent societies are one, it is desirable, indeed it is necessary, that the members and Directors of the Central

Bank should take their proper place in the co-operative sphere, and it would be as illogical to exclude such Directors from supervising or training the constituent societies, either themselves or through the Federation staff placed under their control by the Federation, as it would be to expect the members of the *panchayat* (managing council) of the primary society to abstain from supervising or training the individual members.

Accepting the principle that the ideal to be aimed at is a system of societies and banks owned by the agriculturists themselves, that is to say, owned by the primary societies—and few would deny that this is the ideal at which co-operation aims—it is difficult to see how as the movement progresses it is possible to avoid entrusting training, organization and propaganda work to Directors and members of Central Banks. Mr. Ewbank states that in Bombay training and supervision are entrusted to guaranteeing Unions and in places where there are no Unions to local co-operators and chairmen of first rate societies. In the Central Provinces also training and supervision are entrusted to guaranteeing Unions and to representatives of primary societies sitting on Circle Union Committees. But the difference is that Circle Unions are members of the Central Bank, and chairmen of first rate societies and local co-operators of any eminence are without exception either members or Directors of the Central Bank. In fact as agriculturists accumulate profits and become themselves their own capitalists, it is inevitable that those individual shareholders in the Central Bank not otherwise connected with co-operation and out of sympathy with it should be gradually replaced by representatives of the primary societies; as this change occurs it becomes impossible and undesirable to disassociate the members of the Central Bank from controlling and regulating the primary societies, for those members are merely representatives of the societies and their control is not an outside control by persons whose interests are conflicting with those of the movement but inside control by the properly educated and more enlightened co-operators themselves.

Now, as regards the control of staff, we have always made a distinction between the banking staff as such which is paid for out

of the profits of the Central Banks and engaged in verifying the material assets owned by borrowing societies and looking after their trustworthiness in the interests of the shareholders, and the Federation staff which is paid for not by the Central Banks but by the Federation out of its own funds and which in addition to training and sometimes organizing societies visits each society at stated intervals and writes up its accounts. I should explain here that owing to the backwardness of education in the Central Provinces very few out of the several thousand societies comprise members sufficiently literate to write their own accounts. The primary societies have always been taught to regard the members of this travelling Federation staff as their servants and not the agents of the Central Banks. It has been impressed on them that the pay of this staff is provided by their own contributions to the Federation, and the few irregularities which have occurred on the part of the staff had been brought to light with surprising rapidity by the primary societies. The local control of this staff is entrusted frequently, though not necessarily, to the Honorary Secretary of the Central Bank, and this appears to have given rise to the idea that the whole control of primary societies is centred in the bank. But it should be remembered that the control of this staff is entrusted by the Governor of the Federation to the Honorary Secretary of the bank as the agent and local representative of the Federation. It is not essential that it should be so entrusted, and from time to time in some Central Banks members of the Federation staff have been placed to work under the chairmen of local Unions and well-known *sirpanches* of primary societies, and in the event of any abuse of the kind indicated by Mr. Willoughby in his report it would be open to the Governor of the Federation to entrust the supervision of the local Federation staff to any other co-operator or several other co-operators as agents of the Federation.

Mr. Ewbank quotes at length the analogy which Mr. Crosthwaite draws[1] between the units of the co-operative system and the units of the Army, and concludes, " the gospel of centralization

[1] " Co-operative Studies and the Central Provinces System," part III, chapter I.

could scarcely be preached in a more unequivocal language." It is always dangerous to extract quotations without reference to their context, and a very cursory perusal of the chapter referred to would convince the reader that the author's intention was not to preach centralization but to combat excessive individualism and to show that discipline is implied in co-operation whether it be co-operation of individuals or of societies. The opening words of the chapter read :

"The main principle upon which the Central Provinces system of co-operation is based is that, apart from the necessary control by Government of a movement deeply affecting public interests, nothing must be done for co-operators (*i*) which they ought to do for themselves, (*ii*) which they are competent to do for themselves"; and again later,[1] "Quite a common idea among the educated pioneers of the movement is that, though Central Banks can be managed by them, the village societies cannot and need not be managed by their members. That is to say, self-government may be very good for a Central Bank but is very bad for the societies working under that bank. It is difficult to understand the reasoning which permits sincere and thinking men to fall into an error of this kind. Unless the societies are instructed and patiently trained, they will never know what self-help is, and unless they are left to apply what has been taught them, they will never know what self-help means. A Central Bank which does not train its societies to independence is not doing its duty and is working on lines which are not only wrong but injurious to the country."

Surely it is not centralization but decentralization to the widest extent compatible with co-operation which is here preached. But co-operation implies discipline and self-sacrifice ; this is clear enough in the village society, and it would appear illogical and inconsistent to emphasize the importance of discipline and self-sacrifice among the individual members of a primary society and to deny their necessity when co-operation advances a step further and becomes co-operation between societies instead of between individuals.

[1] *Ibid.*, paragraph 253.

The truth is, the Central Provinces system is not a centralized but an unified system. The whole co-operative movement is regarded as a single body in which each member performs its proper function. Issues which can be decided by the primary societies cannot be decided by the individual members of such societies; so also while some functions must be entrusted to the Directors and members of the Central Bank as representing the societies in a district, other functions must be entrusted to the Co-operative Federation as representing the whole movement. We recognize that co-operation does not begin and end in the village. There must be co-operation between societies working upwards from the Circle Unions to the Central Bank and Provincial Bank, and when the time comes, the All-India Federal Bank, and each part of the co-operative organization should perform those functions for which it is best fitted. One of the illustrations which Mr. Ewbank gives of matters in which the liberty of primary societies is unduly fettered is the investment of reserve fund and the purchase of shares by primary societies in the Central or Provincial Banks. Why, he asks, should the societies be compelled either to take shares in the Central Banks or to invest the reserve fund outside their own societies? We should reply that the members of primary societies are incapable of investing their reserve funds in any other way than in their own working capital because they are not sufficiently advanced to appreciate the matters at issue. It will of course not be disputed that an agricultural society, even though extremely advanced, could not be expected to appreciate the rival merits of the English War Loan and the Indian War Loan in the present state of exchange; and any investment of this sort as a matter of course would have to be done for them. But leaving minor points like this on one side, we would maintain that inasmuch as the reserve fund represents in the Central Provinces the whole, and in other provinces a very large portion, of the profits of primary societies, the whole future of the movement depends on its proper utilization. If the primary societies, that is to say the agricultural classes, are ever to own their own Central Banks and their own Provincial Banks, then the investment of the reserve fund must at present be left in the hands of the more

enlightened people in whom the primary societies by electing them as their representatives have displayed their confidence. If an All-India Federal Bank is ever to be more than a dream, it is to the accumulated reserve fund of primary societies that we must look for the capital necessary to establish such a Federal Bank. Further, if the agricultural classes are ever to advance, if they are ever to learn to manage their own affairs, and by their chosen delegates the affairs of Central Banks, Provincial Banks, and the All-India Federal Bank if established, it is to the educative influence of representative institutions as displayed in the Co-operative Federation that we must look for the necessary stimulus to raise them from the apathy and indifference in which they are now sunk.

MANURES IN THEIR RELATION TO SOILS AND CROP PRODUCTION IN THE CENTRAL PROVINCES.*

BY

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THE four principal soils of the Central Provinces are the alluvial soils of the Nerbudda valley which corresponds to the wheat tract, the black cotton or trap soil of the cotton tract, and the lateritic and metamorphic soils of the rice tract. Without manure and irrigation most of the area under these soils has reached the stage of maximum impoverishment and now yields approximately 600 lb. of wheat, 300 lb. of *kapas* (unginned cotton), and 900 lb. of paddy per acre, respectively, without irrigation. Given irrigation without manure, the crop outturns are increased by approximately 100 lb. of wheat, 30 lb. of *kapas*, and 550 lb. of rice per acre, respectively.

If cattle manure were available in sufficient quantities at present prices, there would be little chance of finding any other manure which could compete with it. But in the Central Provinces much of the cattle-dung is used as fuel, and in most districts, even that part of it which in the rainy season cannot be dried as fuel is left exposed in an open heap together with the ashes of dung which has served its purpose as a fuel. Ordinary village manure made in this way contains on an average 0·46 per cent. of nitrogen, while cattle manure properly stored on Government farms in the provinces contains 0·68 per cent. Nitrogen which is the one constituent

* A paper read at the Fifth Indian Science Congress, Lahore, January, 1918.

in which our soils are so deficient happens to be the particular one which is wasted to the greatest extent by the cultivator, for in the process of burning, over 97 per cent. of the nitrogen of cattle-dung is dissipated. It has been proved, too, that the rain of tropical countries in general does not supply the soil with a greater amount of nitrogen than the rain of temperate climates, the average total for tropical countries being only 3·54″ per acre annually. While the quality of cattle manure is very poor, the quantity available every year is very small, being only about one cartload per acre of crop grown. If every field were to be manured at intervals of 8 years, the quantity of manure available per acre would only be about 64 mds., or approximately 8 cartloads. But a very considerable part of the total quantity of cattle manure used is, as a matter of fact, applied not to the fields in which our staple crops are grown but to cane and garden lands. This unequal distribution of the supply still further reduces the quantity available for open field cultivation. How to meet this deficiency in the supply is one of the problems to which the Agricultural Department has been giving serious attention for the last 12 years, and a large programme of manurial experiments has been carried out on the Government experimental farms with the view of finding manures which can be used to supplement the very inadequate supply of cattle-dung at present available. In describing the results obtained I shall confine my remarks to the rice and cotton tracts with which I am better acquainted.

The application of enough cattle-dung to supply 10 lb. of nitrogen per acre has added from Rs. 10 to Rs. 15 to the net acreage profit on rice cultivation. The same amount of nitrogen applied as poudrette has increased the net profit by from Rs. 15 to Rs. 20, while the same quantity applied as night-soil has increased it by from Rs. 20 to Rs. 30 per acre. The application of calcium cyanamide and of bonemeal separately and of bonemeal in combination with saltpetre has resulted in a dead loss. Bonemeal combined with sulphate of ammonia has generally given a small profit as have also dried leaves and tank silt. Castor cake has given a small net profit in some series only: in others its application resulted in a loss.

The only manures which have consistently given large acreage profits are cattle manure, night-soil, and poudrette. The supply of night-soil and poudrette is so small and the difficulty of getting sweepers to apply them so great that they are only of secondary importance as an economic factor in crop production. It therefore becomes evident that of the manures available in any quantity cattle-dung is the only one which really counts. The use of green manures therefore suggested itself as being the most likely method of finding a substitute for cattle-dung. Owing to the peculiar nature of our rainfall which extends from the middle of June to the end of September, a period which coincides with the period of greatest growth of the rice plant, the only crop which is at all suitable as a green manure for rice is a fast growing one which, when sown in the middle of June, will be ready for application by the end of July at which time the seedlings are being transplanted. Sann-hemp (*Crotalaria juncea*) has been found to be a sufficiently fast grower, but when grown in the bunded rice plots its growth is checked so much by the heavy rainfall of the early monsoon that it is found impossible to raise any quantity of it in time for ploughing in for the succeeding rice crop. *Dhaincha* (*Sesbania aculeata*) thrives much better under the same conditions, but is too slow a grower. The difficulty in producing a sufficient bulk of *sann* has been finally got over by growing it in the open fields reserved for *rabi* (winter) crops. In one acre of *rabi* land about 300 mds. of *sann* per acre can be grown in time for ploughing in for rice. This suffices as a green manure for 3 acres of rice. The analysis of this green sann-hemp showed that it contains 0·57 per cent. of nitrogen, so that it is about equal in manurial value to cattle-dung bulk for bulk. Over the greater part of the rice tract of the Central Provinces, the *rabi* or winter crop area lying fallow during the rains and therefore available for the production of sann-hemp as a green manure for rice, is almost equal to the area under rice. It is possible therefore to raise much more green manure than is needed for rice and without reducing the area under *rabi* crops such as wheat, gram, linseed, etc. The practice will, we believe, be a positive advantage, as far as *rabi* crops are concerned, as the standing crop of *sann* helps to check the

growth of weeds and to reduce to a minimum the damage which would otherwise be done to the fields left fallow during the monsoon. The manurial value of the roots of the *sann* for the *rabi* crop should also be appreciable. Experiments to test it have been started. This new method by which fallow land is utilized for the production of green manure for rice, is applicable to over 4 million acres of rice land in the Central Provinces, and I anticipate that it will largely solve the manurial problem as far as the rice tract is concerned. It was tried by landowners in over 40 villages last year. The average increase obtained from the fields manured in this way amounted to over 600 lb. of paddy per acre, worth approximately Rs. 15. The cost of raising this green manure was about Rs. 3 per acre manured, leaving a net profit of Rs. 12 per acre.

The use of cake as a cane manure was demonstrated by the Department for the first time six years ago. This manure, though not previously in use anywhere in the provinces, has now caught on, and is being used in larger quantities every year by cane-growers. Sann-hemp, applied at the rate of 10 tons per acre to the sandy loams in which cane is generally grown in the rice tract, has, when supplemented by a dressing of 15 mds. of cake, given yields of about 20 tons of cane per acre, which, when converted into *gur*, is worth approximately Rs. 330. The cost of the manure applied in this case is only Rs. 33. The average outturn of cane for the provinces, manured with cattle-dung, is only 11 tons, which is worth approximately Rs. 184. By this new method of manuring the net profit on cane cultivation can be increased by about Rs. 146 per acre.

In the cotton tract the value of manure is more highly appreciated than in other parts of the provinces. Cotton pays better than rice or wheat, and cultivators have come to realize the economic value of cattle manure. The price per cartload is R. 1 as against 8 annas for the greater part of the rice tract. But in the cotton tract, too, much valuable manure is wasted. No attempt is made to conserve the urine which is so rich in nitrogen. To meet this formidable obstacle to good cultivation, the dry-earth system of conserving urine has been demonstrated in this tract. Experiments

carried out with urine earth on the Government farms have shown that, in the year of application to *jowar* (*A. Sorghum*) and cotton fields, the urine of a bullock for any definite period of time, is equal in manurial value to its solid excreta for the same time. By this system of conserving the urine, dry earth to a depth of 6″ is spread in the stalls. This earth is removed to the manure pit once a month, and fresh earth is put into its place which, in turn, absorbs the liquid portion of the animal's excreta for the succeeding month. By adopting this system of conserving cattle urine the intrinsic value of the manurial supply of a village can be doubled at a very small cost.

Cotton cultivation on well manured land is so profitable at the prices which have prevailed of recent years that it would pay the cultivator to manure his cotton, even if cattle manure were three times as expensive as it is at present. The supply, however, is so very inadequate that there is none available for sale in the villages. Green-manuring is not a feasible proposition in this tract as it would have to be grown at the expense of cotton and *jowar*, for the manuring of *rabi* crops of which the area is comparatively small. To meet the full requirements of the cotton tract, therefore, it will be necessary to fall back on manures not at present in use, and this we hope to be able to do by the use of nitrate of soda on a large scale, and by the utilization of such quantities of manurial cakes as are manufactured locally. If it were possible to offer nitrate of soda for sale at about Rs. 10 per cwt., the demand for it would, I believe, be large. On the strength of the results obtained from the trials of nitrate of soda on the Akola farm, the Commissioner of Berar put up a proposal this year to the effect that about a lakh of rupees worth of this artificial should be offered for sale to cotton-growers in his division which constitutes the greater portion of the cotton tract. The price, however, had risen so enormously owing to the war that it was considered inadvisable to make large purchases at the present time. There is little doubt but that it would pay handsomely to apply nitrate costing Rs. 10 per cwt. as a topdressing to cotton at the rate of 60 lb. per acre. This quick-acting manure is specially suitable for short-season cottons.

In conclusion, I should like to lay stress on the fact that though in the Central Provinces and in other parts of India much has already been done by the Department of Agriculture to solve the problem of economic manuring, a poor cultivator will not be in a position to reap the full benefit from the results of these researches, until we make it easy for him to obtain these manures. We require, in short, an efficient organization which will provide both for the supply of manures and for the financing of purchasers who wish to buy them. This may possibly be done later on a large scale through co-operative societies. To pave the way for co-operative societies it may be necessary to finance the cultivator direct to start with. It should be quite feasible for Government to provide a definite sum to be given each year as *takavi* for the extension of agricultural improvements recommended by the Department of Agriculture. This has, as a matter of fact, been done in the Central Provinces, and it is a policy which is well worth the consideration of any provinces which may not yet have adopted it.

NOTES ON THE HYDROCYANIC ACID CONTENT OF JOWAR (*ANDROPOGON SORGHUM*).

BY

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It has long been known that a cyanogenetic glucoside, called dhurrin, is present in *jowar* in certain stages of its growth. This glucoside is not poisonous by itself, but it breaks up, in contact with an enzyme which is present in the plant tissues, into several compounds, one of which is hydrocyanic acid. It is on account of the formation of this latter substance that *jowar* acts as a poison, and cases of poisoning of cattle by the plant are not of infrequent occurrence. In 1915 a number of cattle deaths took place near Sabour. That year there was a particularly long period of dry weather immediately after the crops were planted, a condition which does not happen every year. It was then suggested that, owing to the insufficiency of moisture in the soil, the plants were stunted and did not grow properly, and that, in consequence, there was an excessive development of the cyanogenetic glucoside which yielded the poison. It was then proposed to investigate the circumstances which help the accumulation of the poison-producing compound in the *jowar* plants.

Accordingly, at the suggestion of Mr. Somers Taylor, Agricultural Chemist to the Government of Bihar and Orissa, a trial was made to find out the effects of different times of planting, and also of water-logging, on the formation of the glucoside in *jowar*. The idea was to sow some of the plots very early, well in advance of the usual time, so as to obtain, as far as possible, a condition similar to that of 1915, *viz.*, a period of comparatively dry weather in the

growing period, and also to sow some of the plots very late, after the rains have well set in, so as to have always an excessive quantity of moisture in the soil. Unfortunately the rains were late in coming, so late as to make very early planting impossible, and there was no abatement of rains once they had set in, so that the first condition of comparative drought was not obtained. On the other hand, owing to heavy and frequent rain, all the plots were water-logged, and the plants, weak and stunted, even after six weeks, showed no tendency to grow up at all. A very small quantity of hydrocyanic acid was all that was obtained—a fact which suggests that water-logging is unfavourable to the formation of cyanogenetic compounds in *jowar*. There was no case of cattle-poisoning* that year by *jowar*. The following table illustrates the result :—

TABLE I.

Plot No. I E. P.

Age of plants	Date of analysis	HCN%
Over 4 weeks ...	6th July 1916	0·000912
5 ,, ..	9th ,, ,,	0·000456
Over 5 ,, ...	12th ,, ,,	0·000500
Over 6 ,, ...	18th ,, ,,	Traces
	Plot No. II E. P.	
4 weeks ..	6th July	0·000608
About 5 ,, ...	9th ,,	0·000512
Over 5 ,, ...	12th ,,	0·000456
Over 6 ,, ...	18th ,,	Traces

The experiment was repeated in 1917. The first of the plots were sown on 12th May. Before that there were only two inches of rain distributed over six days, and there was no rain after until the 27th May. But just on the night previous to the day when the first samples were collected, there was a shower (½ inch) of rain, so that the actual condition of the plants during the period of drought was not exactly known. An excessive quantity of prussic acid was found, which, however, fell down to less than half in about three weeks, during which period there were occasional showers.

* A few cattle deaths reported from Bettiah were suspected to be due to the cattle eating a weed, *Andropogon helepensis*, which is also, like *jowar*, capable of yielding HCN. But at the time the weeds were collected and received at Sabour for examination, no HCN was obtained from them.

The results were not even on all the plots.

TABLE II.

Date of analysis	Plot I E. P.	Plot II E. P.	Plot III E. P.
	HCN%	HCN%	HCN%
28th May ...	......*	0·196*	......*
5th June ..	......*	0 099*	......*
8th ,, ...	0·121	0·092	0·124
12th ,, ...	0·060	0·045	0·057
19th ,, ...	0·075	0·025	0 021
26th ,, ...	0·041	0·004	0·013
3rd July ...	0·032	0·009	0·008
10th ,, ...	0·019	0·003	0·009
17th ,, ...	0·024	......	......
31st ,, ...	0·012	......	......
13th August ...	Traces	......	......

The poisonous properties most persisted in the plot E. P. I. This plot was, however, marked by a more vigorous grcwth, as is evident from the greater average weight of the plants, and also by the greener and more healthy appearance of the leaves (Table III).

TABLE III.

Average weight and height of a plant.

Date	Plot I E. P.		Plot II E. P.		Plot III E. P.	
	Weight	Height	Weight	Height	Weight	Height
3rd July ...	122 gms.	150 cm.	108 gms.	170 cm.	112 gms.	180 cm.
10th ,, ...	338 ,,	200 ,,	293 ,,	200 ,,	245 ,,	200 ,,
17th ,, ...	367 ,,	250 ,,	.. ...	... ..	267 ,,	200 ,,

Here is a result which is contrary to all expectations, for it has long been believed that a healthy and vigorously growing *jowar* plant yields much less poison than its weak and stunted brother. This result received a remarkable confirmation from the observations of some later plants. In the case of thickly sown plants, what always happens is that a good many receive a much later start and lag behind, in the matter of growth, their stronger and older brothers. This may be due to malnutrition or to the secretion of injurious products by the older plants, but that strong and healthy plants contain more prussic acid can be seen from the following table :—

* As the plants were then very small, the samples collected from the three plots were analysed together.

TABLE IV.

Plot IV (Usual time).

Date of analysis	Average weight	Average height	HCN%
16th July, 1917 ...	17 gms.	80 cm.	0·0080
	81 ,,	127 ,,	0·0151
23rd July, 1917 ...	22 ,,	100 ,,	0·0090
	143 ,,	170 ,,	0·0153
30th July, 1917 ...	26 ,,	96 ,,	0·0075
	191 ,,	200 ,,	0·0047
	Plot V (Usual time).		
16th July, 1917 ...	17 gms.	75 cm.	0·0076
	122 ,,	120 ,,	0·0190
23rd July, 1917 ...	32 ,,	85 ,,	0·0053
	117 ,,	160 ,,	0·0065
30th July, 1917 ...	12 ,,	95 ,,	0·0128
	244 ,,	196 ,,	0·0110
6th August, 1917 ...	26 ,,	119 ,,	0·0045
	547 ,,	216 ,,	Traces

The time of planting does not appear to have any effect on the formation of dhurrin. With the three sets of plots sown at different times, and nearly at a month's interval between one and the next, there was no difference between the first and the second set, both as regards the maximum yield of the poison or its rate of diminution as the plants grew up, but the third only showed half the maximum quantity of the poison, though the rate of diminution of the poison was very much the same. The low maximum of the third set which was planted last at a time (8th July) when there was an excessive amount of moisture* in the fields, and when there were heavy downpours of rain previously and subsequently to the sowing, may be due to an abundance of soil moisture.

The following table is given for comparison :—

TABLE V.

PLOT III L. P.			PLOT II E. P.			PLOT IV U. P.		
Date of sowing	Date of analysis	HCN %	Date of sowing	Date of analysis	HCN %	Date of sowing	Date of analysis	HCN%
8-7-17 ...	25-7-17	0·0452	12-5-17	23-5-17	0·1960	7-6-17	25-6-17	0·0910
	1-8-17	0·0381		5-6-17	0·0990		2-7-17	0·0904
	9-8-17	0·0279		8-6-17	0·0920		9-7-17	0·0211
Planted very late.	15-8-17	0·0285	Planted very early.	12-6-17	0·0450	Planted at the usual time.	16-7-17	0·0079
	21-8-17	0·0173		19-6-17	0·0250		23-7-17	0·0153
	29-8-17	0·0148		26-6-17	0·0042		30-7-17	0·0091
	5-9-17	0·0050		3-7-17	0·0093		6-8-17	0·0075
				10-7-17	0·0031		14-8-17	
				17-7-17	Traces			Traces

* See Table of Rainfall (Table VII).

It is therefore obvious that while the time of planting by itself has little or no connection with the formation of the glucoside, yet a crop planted late has a much better chance of producing smaller quantities of the poison on account of the abundant moisture which is generally found in the soil in such a time.

Dhurrin occurs principally in the leaves and young shoots. There is a very much smaller quantity of it in the stalk, from the time the plant grows to an appreciable height, *viz.*, about 100 cm. The percentage of total nitrogen in the leaves is also proportionally greater than in the stalks, evidently owing to an accumulation of non-protein nitrogenous matter (Table VI). In ratooned *jowar*, when young shoots spring up from old stalk, the *jowar* is considered to be highly poisonous, although the parent stock at the time might contain practically no glucoside. This occurrence of the glucoside, especially in the places of active metabolism, is suggestive of some compounds being formed and fixed by the plant in such forms.

The exact part played by it in plant economy can only be known when the factors influencing its formation are known with certainty. The cyanogen may be an intermediate product in proteid formation, or it may act as a harmone, which is the general name of a variety of substances which are able to penetrate the walls of plant cells, thereby disturbing the equilibrium within the cell and producing changes which involve alterations of the concentration and the liberation of hydrolytic enzymes. If the former view be correct, it would signify that strong and healthy plants, which form more proteids than weaklings, would gather more glucoside at a time when proteid formation is very active. It is very suggestive that the total nitrogen percentage in a plant shows more or less a steady diminution as the plants grow up, but not at such a rapid rate as the hydrocyanic acid. No reliable evidence has been obtained that weak and sickly plants can produce, as a rule, more hydrocyanic acid ; in fact, evidence, as far as has been obtained, points to the contrary. Let us examine the factors which have so far come to our knowledge as likely to bear on the production or otherwise of the glucoside. In the first place, an abundance of moisture in the

soil is always associated with a low percentage of dhurrin, and sickly plants growing in water-logged soils contain only a minute quantity. The contrary is also probably true, in spite of scanty experimental evidence, *viz.*, a deficiency of moisture in the soil or a dry period is conducive to excessive glucoside production in *jowar*. There is no doubt that the experience of the general body of cultivators is in favour of this view, and here and there facts have been brought out suggestive of it, but apart from that, no further experiments appear to have been carried out which would fully bear out the cultivators' views. Secondly, the rate of growth has long been thought to have some correlation to the poison-producing power in the plant, the most poisonous plants being those which make a very unfavourable growth. It has been shown that this is not necessarily true, and that in the case of strong and weak plants growing side by side in the same field, it is not the weak plants alone which always yield the greater amount of hydrocyanic acid. Thirdly, there is a far greater amount of nitrogen accumulation in the leaves than in the stalks. The appearance of this greater quantity of nitrogenous substances exactly in the parts where the greatest quantity of hydrocyanic acid occurs, is an indication that the production of the glucoside is in some way correlated with the production of the nitrogenous matter, and lends support to the theory that prussic acid is an intermediate product in proteid formation, and that its occurrence is an evidence of nitrogen assimilation. Water-logging presents a very unfavourable condition for nitrogen assimilation, as it prevents bacterial activity and stops nitrification. This accounts for the production of merely traces of hydrocyanic acid in the crops of 1916. In warm dry weather, before the rains have actually fully set in (according to Leather's drain-gauge experiments at Pusa[1]), the seat of nitrification is much nearer the surface and therefore presents a more favourable condition for nitrogen assimilation by the young plants whose roots at the time do not penetrate deep enough. With the coming in of the rains the principal seat of bacterial activity

[1] *Memoirs of the Department of Agriculture in India, Chemical Series,* vol. II, no. 2.

moves downwards, and there is a likely loss of soluble nitrates by overflooding and drainage, and partly on this account and partly on account of the very rapid rate of growth, when the glucoside formed is rapidly utilized to furnish higher and more complex compounds, there is less and less hydrocyanic acid obtained as the plant grows up until it is fully grown. Thus the accumulation of the acid in the young plant in normal years and its diminution with the age and growth of the plants receive an explanation. But in years of scanty rainfall, as the vital activities of the plant are retarded on account of lack of moisture, the utilization of the cyanogenetic compounds will probably take place much more slowly, and the plant will indicate a quantity of the poison which it cannot at once get rid of. These are, however, still suggestions and have to be substantiated in the light of further experiments.

It would therefore appear that the weather is mainly responsible for the development of the poisonous elements in the *jowar*. The soil is only of minor importance and is accountable only so far as it can hold up nitrogenous food materials to the plant. Brunich in Queensland found that the poisonous properties of *jowar* increased with improved fertility, and Treub[1] stated that nitrates exert a direct influence on the production of hydrocyanic acid. Against this there are American results[2] that in a rich soil, however well provided with plant food, an addition of nitrogenous fertilizers has been found to exert no appreciable effect, while in a poor soil there appears to be an increase, though to a slight extent. The soil, therefore, though it may help in the production of the glucoside, is only a minor factor, and the weather, notably rainfall, is the factor of greater importance.

It is proposed to continue the study still further.

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[1] Treub, M. *Ann. Jard. Bot. Buitenzorg*, 2, ser. 4, pt. 2, pp. 86-142 (noted in *Expt. Station Record*, vol. XVII, p. 347).

[2] *Journal of Agricultural Research*, vol. IV, no. 2.

TABLE VI.

Showing the percentages of hydrocyanic acid and of nitrogen in different parts of jowar *plants at different stages of growth.*

Plot No.	Date	HCN%	N%	HCN% in leaves	N% in leaves	HCN% in stalk	N% in stalk
E. P. I ...	8-6-17	0·12100	0·5060				
	12-6-17	0·06000	0·6260				
	26-6-17	......	......	0·0128	0·500	0·00750	0·201
	3-7-17	0·03240	0·5130	0·0565	0·677	0·01660	0·404
	10-7-17	0·01870	0·4580	0·0452	0·754	0·00603	0·316
E. P. II ...	8-6-17	0·09200	0·4030				
	12-6-17	0·04500	0·4920				
	19-6-17	0·02500	0·3730	0·0230	0·495	0·01500	0·161
	26-6-17	0·00420	0·3880	0·0075	0·547	0·00380	0·297
	3-7-17	0·00930	0·3580	0·0143	0·630	0·00600	0·352
E. P. III ...	8-6-17	0·12400	0·4200				
	12-6-17	0·05700	0·4750				
	19-6-17	0·02100	0·3260	0·0300	0·496	0·05100	0·215
	26-7-17	0·01260	0·4460	0·0136	0·547	0·01130	0·351
	3-7-17	......	......	......	......	0·00750	0·291
U. P. I ...	25-6-17	0·09100	0·4650				
	2-6-17	0·09040	0·6040				
	9-7-17	0·02110	0·4820				
	16-7-17	0·00792	0·6640				
Stunted plant) ...	23-7-17	0·00905	0·3504				
(Strong plant) ...	23-7-17	0·01530	......	0·0317	0·299	0·00603	0·082
(Stunted plant) ...	30-7-17	0·00754	0·2030				
Do. ...	6-8-17	0·00151	0·2940				
U. P. V ...	25-6-17	0·82900	0·4800				
	2-7-17	0·82600	0·6160				
	9-7-17	0·21600	0·5060				
	16-7-17	0·00758	0·4970				
	23-7-17	0·00650	......	0·0098	0·208	0·00452	0·068
(Stunted) ...	30-7-17	0·01280	0·2080				
	6-8-17	0·00452	0·2740				

TABLE VII.

Table of rainfall in inches, May to August 1917, *recorded in the Sabour Agricultural Station.*

Day of the month	May	June	July	August
1	......	1·95	0·07	2·47
2	......	......	......	3·33
3	......	......	0·70	0·45
4	0·43	......	3·45	0·20
5	0·03	......	......	......
6	0·85	......	......	......
7	0·05	......	......	......
8	......	......	0·07	0·12
9	0·03	0·40	......	0·45
10	......	......	......	0·48
11	0·72	......	0·31	1·53
12	......	......	......	1·00
13	......	......	1·40	0·04
14	......	0·46	......	0·14
15	......	0·58	......	0·04
16	......	......	......	......
17	......	......	......	......
18	......	0·17	0·16	0·96
19	......	......	0·15	......
20	......	......	......	......
21	......	0·32	......	0·04
22	......	0·15	......	......
23	......	0·61	......	......
24	......	......	1·57	......
25	......	0·50	0·28	0·27
26	......	......	0·30	......
27	0·59	......	1·48	0·34
28	0·33	......	0·50	......
29	......	......	......	......
30	0·63	0·55	0·34	......
31	......	......	......	......

GRAFTING THE GRAPE-VINE.

BY

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We have great pleasure in publishing this article by an actual cultivator who has made experiments on his own account, and hope it would be of special interest to the readers of the Journal. It is needless to add that contributions from intelligent, practical cultivators, embodying the results of their experience, observations and experiments, will always be welcome to us.—[Editor.]

Among other advantages of grafting the grape-vine, it is claimed that the effect of grafting is to produce a constant weakening of the scion with increased fructification, a greater number of closely set bunches with large berries, more juicy and frequently richer in saccharine matter, and an early ripening.[1] Husmann also believes that grafting increases fruitfulness, the temporary obstruction seeming to have the effect upon the graft of making it produce more and finer fruit than on its own roots.[2] He has also recorded similar experience of other eminent growers.

The matter seemed worthy of investigation and led me to undertake a few experiments as already remarked in Bulletin No. 71 (of 1915) of the Bombay Agricultural Department. The principal varieties of grapes grown at Nasik are only four. Bhokari,

[1] Viala and Rivaz. "Grafting for American Vines."
[2] Husmann. "Grape-growing and Wine-making."

being a good cropper, is much in favour and largely grown, while Fakari, Sahibi, and Hafsi or Kali, being very shy bearers, are never grown beyond a few vines in a plantation, though these varieties are decidedly superior. If grafting produced increased fruitfulness the problem here was to ascertain whether some of our shy bearers could be made to yield more and better fruit by grafting them on other stock.

I had no clear notions about the influence of the stock upon the scion. I vaguely imagined that Bhokari, being very prolific, might exert a favourable influence upon the scion. Also, as Fakari, Sahibi, and Kali are very vigorous growers, producing abundant foliage—perhaps at the expense of fruit—I should be able to check this habit of vigorous growth by selecting a stock which was a moderate grower by habit, such as Bhokari. On these considerations I decided to use Bhokari as stock.

The next point was to select the method of grafting. Various methods of grafting and budding have been suggested. As I had very little experience in grafting, I chose to operate in four different manners, namely :—

(1) Grafted cuttings,
(2) Grafting by approach,
(3) Crown grafting, and
(4) Side-cleft grafting.

GRAFTED CUTTINGS.

For successful grafting it has been found that the temperature should not exceed 20° or 25°C. As cuttings could only be obtained in the beginning of October, I tried grafted cuttings at this time, though the temperature condition was not favourable. All the trials failed successively for three years (1914 to 1916). In preparing the graft the cut has to be made one-half to one inch above and below a node upon the stock and scion respectively. This left the knitting surface much too small. The grafted cuttings should have been kept for callusing in fresh moist sand before they were set to root. I admit that I had not followed this instruction.

Be it from whatsoever cause, none of the grafted cuttings rooted, and I gave up the trials after three years.

GRAFTING BY APPROACH.

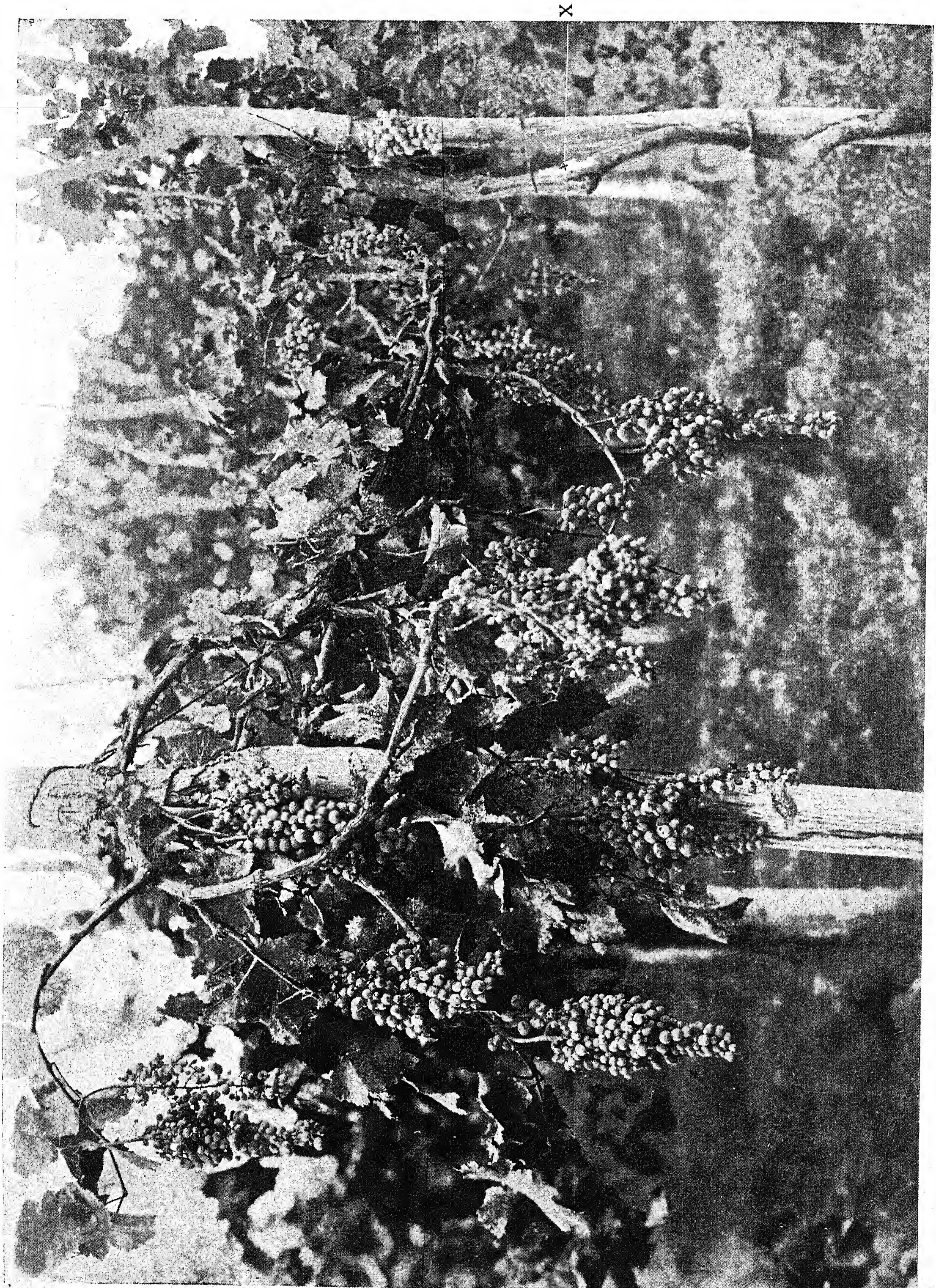
In 1913 a *mali* from the Ganeshkhind Botanical Gardens, Kirkee, grafted on two Bhokari vines in one of my plantations, operating by the usual method of grafting by approach (tongue graft). Both the grafts knitted well and were successful. Fakari canes were used for scions. Both grafts were pruned in April, 1914, to form the head. One of the grafts was accidentally destroyed while ploughing. The other graft was again pruned for fruit in October, 1914. The stock of this graft is 40″ long and the scion after heading in was 24″ long. It gave six bunches of good size, while there were only four small bunches on the parent vine, that is, from which the scion was taken. The result was tolerably fair and encouraging. This graft is bearing splendidly every year.

I have found that grafting by approach is a much surer method —the grafts knit well and the chances of failure are few. I have other grafts prepared by the approach method. One is bearing fruit beautifully. The length of the stock is 24″ and that of the scion after heading in is 40″. Three other grafts had to be transplanted elsewhere in April, 1917, as they happened to be in an isolated condition, but they have not as yet recovered from the shock.

But there is one disadvantage with this method. As the number of vines for the scion is only limited in a given plantation, only a few vines can be grafted by this method. I thought of trying a method which shall be quite independent of the position of scion vines, which is described below.

CROWN GRAFTING AND SIDE-CLEFT GRAFTING.

In October, 1914, I tried 10 crown grafts and 10 side-cleft grafts. Four crown grafts were put up below the ground and the rest above the ground. Only one graft above ground knitted well and was successful. Again, in the following year, out of nine crown grafts and nine side-cleft grafts, only one crown graft above ground was



Grafted grape-vine—Fakari on Bhokari. The cross indicates the union.

successful. The trials in 1916 and 1917 failed to give even a single successful graft. From this it appears that crown and side-cleft grafting are much more difficult and cannot be practised as a general method.

So far my object had not been attained. I wanted to find out a method of grafting by which the variety of any existing plantation can be changed at will. A new plantation can be put up by growing together and training mixed cuttings of different varieties, and when the heads are formed, the choice variety may be grafted upon another stock by the approach method. I have obtained a few grafts in this manner. But it takes up much time to train the vines before they can be grafted upon and, therefore, foreign varieties cannot be propagated rapidly by this method, nor can their possibilities judged within a short time. Crown and side-cleft grafting have a greater significance in the case of untried and foreign varieties; for, by these methods, these varieties can be introduced rapidly and their possibilities judged.

Results.

As a general rule, Fakari vines on their own roots bear quite indifferently. They will not bear fruit at all or bear a few bunches which are quite out of proportion to the large bearing surface on the head of the vines. All the grafts are bearing fruit regularly from the very second year. The quantity of fruit will depend on the bearing surface. As the age of the grafts advanced, the heads were well formed and the bearing surface had increased. There was a corresponding increase in the number of bunches and the weight of the fruit. I am writing this from my observations. I have not kept regular records. Last year the weight of fruit on the graft (approach graft of 1913) must have been 15 lb.; the other approach grafts yielded nearly seven pounds of fruit; the two crown grafts bore quite to my expectation. This year the approach grafts of 1913 had 42 bunches, which weighed 22 lb. (Birds are responsible for considerable loss of weight; only the actual weight is given.) The other approach grafts had 19 bunches which weighed 14 lb. The photograph of one of these two grafts (Plate I) will give a

good idea of the number and size of bunches. The number of bunches on the crown graft of 1914 was 17 and weighed $7\frac{1}{2}$ lb., while the other crown graft of 1915 gave 13 bunches which weighed 6 lb. The bunches on both the grafts were mildewed, which circumstance has adversely influenced the weight. Many of the bunches were of large size. The berries attained normal size. On the other hand the berries on some bunches were undersized. Near each crown graft (close to it) is a companion or sister Bhokari vine which is also in bearing. The grafts are not photographed as it was difficult to isolate their bearing canes from Bhokari for the purpose of photographing. In one of my plantations there are 150 Fakari vines on their own roots. They bear fruit indifferently and are not even paying the cost of their cultivation. This is the first time in five years that they have borne fruit to an appreciable extent. The total weight of fruit on these 150 Fakari vines was 296 lb., or a little less than 2 lb. per vine. The average yield from Bhokari vines is 12 lb. to 15 lb. Individual Bhokari vines do bear 20 lb. to 25 lb. of fruit. From these figures it will be seen that the grafts gave considerably increased quantity of fruit, far in excess of the average of 2 lb. on the 150 Fakari vines on their own roots.

CONCLUSION.

It appears that grafting the grape-vine increases fruitfulness. The grafts give larger and closely set bunches. In some bunches the berries attained normal size, while in others they are undersized. The quality of the fruit is not changed appreciably. From the behaviour of four grafts, it is not safe to assert, as a general proposition, that grafting produces fruitfulness. The indications are, however, that it does produce increased fruitfulness. More experimental work is necessary. Experiments generally do not pay and are even costly. In other experiments with the grape-vines—such as summer pruning or pinching and spraying with ammonia copper carbonate solution against mildew—I have gained; while in trying the crown grafts I have lost 40 well-established vines and permanently injured 40 vines by side-cleft grafting. Besides, such experiments in experienced and capable hands are likely to be

more successful. If the record of my experiments be deemed interesting I hope others will undertake further experimental work.

Next cold weather, I shall grow and train 60 sets of mixed cuttings. Every set will consist of 4 cuttings, two of Bhokari and two of choice variety. Bhokari will be used for stock. For the scion, cuttings of Fakari, Sahibi, Kali, and Kandahari will be grown.

When the vines are established and heads are formed I propose to graft the choice varieties by the approach method.

SOME OBSERVATIONS ON AGRICULTURAL WORK IN EGYPT, AMERICA, AND JAPAN.

III. JAPAN.

BY

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(Concluded from page 280, vol. XIII, pt. II.)

I SPENT twenty-four days in Japan and confined my enquiries to the subjects of—

(*a*) agricultural education; and

(*b*) introduction of agricultural improvements.

AGRICULTURAL EDUCATION.

A great deal seemed to be going on in agricultural education, especially in technical and elementary schools. Agricultural education is in charge of the Department of Education in Japan.

Imperial University of Tokio. This has six Colleges or Faculties, *viz.*, Law, Medicine, Science, Engineering, Literature, and Agriculture; the latter has 33 professorial chairs and over 700 students in all. There are also 27 post-graduate students.

The university is well equipped and has attached to it an experimental farm together with a students' farm and a demonstration farm which seem to be very well managed. The average age of pupils entering universities in Japan is high, *viz.*, 23½ years. This is due to the long series of schools through which a pupil must pass before he can be admitted to the university. The course at Tokio lasts three years. The number of regular students is 452 with 286 pupils in addition undergoing special courses. A similar

Agricultural Faculty is attached to the Hokkaido University, but on a smaller scale. The undergraduate instruction is briefly as follows :—

Technical institutes. These are the lowest grade and take pupils who have finished the compulsory elementary education of six years. The number of pupils in these in 1908 was 163,300. The number of these schools now is over 5,000. In this connection I may note, some kind of technical subject is compulsory in the higher elementary schools. Three subjects are given, *viz.*, agriculture, manual training, and commerce, of which one or more is compulsory. The following table taken from the "Outlines of Agriculture in Japan," published by the Agricultural Bureau, indicates the system concisely :—

Educational organs of agriculture.

Jurisdiction	HIGH EDUCATIONAL ORGANS		ORDINARY ORGANS		Organs for agricultural training
	University	Higher Technical School	A Class	B Class	
Department of Education	Agricultural College of University	Practical course of Agricultural College of University Higher Agriculture and Forestry School Higher Sericultural School Higher Horticultural School Training Institute of Agricultural Instructors	Agricultural School Stock farming School Horticultural School Sericultural School	Agricultural School Sericultural School	Agricultural supplementary School

Higher agricultural technical schools. These take graduates of the middle school or those equally qualified. The higher technical schools give a three-year course and turn out men qualified to teach in the middle schools and primary schools. In this class we may reckon the practical courses given at the Universities of Tokio and Hokkaido.

Agricultural schools. For these, pupils who have gone through the six years' compulsory primary course and have subsequently done two years' study in higher primary schools are admitted. The course in these schools extends over three or four years. Each

prefecture has one agricultural school of Class A, while many counties and towns have Class B agricultural school. I visited twelve of the various types of agricultural schools. The education is very general in all of them with agriculture occupying from two to six hours a week according to the class of school. The agricultural training is practical in all the middle and higher schools. I give below the time-table of the Shizuoka Agricultural School, course three years :—

First year	Hours	Second year	Hours	Third year	Hours
Morals ...	1	Algebra ...	2	Morals ...	1
English ...	2	Zoology .	1	Algebra ...	1
Algebra ...	2	L. Language ...	1	Economics ...	2
Botany ...	2	Chemistry ...	2	Chemistry ...	1
Japan L. ...	2	Physics ...	1	Pathology ...	1
Veg. culture ...	3	Morals ...	1	Gymnastics ...	1
Chemistry ...	2	Veg. culture ...	1	Sericulture ...	2
Chinese classics ...	1	Special veg. culture ..	2	Drawing ...	1
History of Japan ...	1	Chinese classics ...	1	F. Language ...	2
Sericulture ...	2	Manure ...	1	C. feeding ...	2
Zoology ...	2	English ...	2	Veg. culture ...	1
Mathematics ...	2	Sericulture ...	1	Forestry ...	2
Drawing ...	1	Drawing ...	1	Japan Lan. ...	3
Gymnastics	2	Insects ...	1	Surveying ...	1
Physics ...	1	Germs ...	2	Fruits ...	1
Entomology ...	1	Plant disease ...	1	Physics ...	1
Geology ...	1	Cattle feeding ...	2	Manure ...	1
Geography ...	1	Geography ...	1	Chemistology ...	1
Writing ...	1	Botany ...	1	Geometry ...	2
		Soils ...	1	Agri. law ...	1
	30	Forestry ...	1	Technical agri. ...	1
		History ...	1	Marketing of agricultural products	1
		Gymnastics ...	2		
			30		30

The course here is typical of most of the middle and higher grade agricultural schools. The subsequent career of graduates is given below :—

Shizuoka Agricultural School.

Graduates	588
At home	316
Government office	63
Various schools	76
Agricultural Society	19
Under counting or prefecture experimental station	21
To banks and other commercial houses	10
To higher agricultural school	19
Military service	34
In foreign countries	14
Dead	16

One of the best agricultural schools I saw was at Kyoto.

To bring out clearly the relation of agricultural education to general education I give below the ordinary school courses in Japan :—

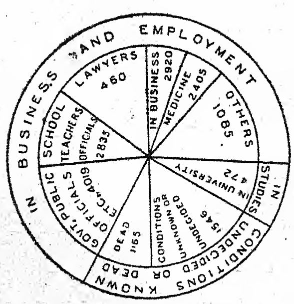
General education.	*Agricultural education.*
(1) Six years' compulsory elementary education	None.
(2) Two years' optional elementary education	Candidates who take this, have choice of 3 subjects, *viz.*, commerce, manual training or agriculture, one of which must be taken.
(3) Middle school course, 5 years	Agricultural schools of Class B and Class A. These are of 3 or 4 years' duration and *do not lead* to University.
(4) Higher and technical schools, 3 years	About 12 agricultural schools of this class exist. Similar technical courses exist in the University.
(5) University	Agricultural College.

It will be noticed from above that the elementary agricultural education tends to draw men from the regular road to the university. Thus the middle school course in agriculture is for boys of 14 or 15 to 18 years old and the bulk of them naturally go to their homes afterwards and do not look for appointments.

The inclusion of agriculture with three optional subjects in the two years' (optional) elementary education is also significant.

From the list of graduates of the Shizuoka School given above it will be seen that by far the greater number return to their homes. This was a school I would class as " Class A Middle School " and was a Prefecture School.

As to graduates of the higher technical schools, a great number of them go to appointments as teachers in lower schools and the education is so general that they are fit for any post in the lower schools.



I give here a diagram taken from the report of the Department of Education for 1914 as to careers of graduates of Tokio, Kyoto, Tohoku and Kyushu Imperial Universities (also including graduates of the old Sapporo Agriculture School).

The course to get through the university is so prolonged that comparatively few can afford to go through it. A great deal of

agitation was going on with a view to reducing the number of years in the full course (19 at present).

The number of students taking university courses in agriculture (400 regular and over 300 special courses at Tokio) does not seem high for a population of 70 millions and for a country with large undeveloped tracts in Hokkaido, Formosa, Chosen, etc.

To grasp the length of the educational course in Japan one may imagine a boy of six years starting school. He finishes compulsory education at 12 or 13. Then follows two years' further elementary course, five years' middle school which brings him to 19 or 20 years old, and then perhaps three years technical or higher grade school before he enters the university. English is compulsory in all schools above compulsory elementary schools. Discipline is invariably excellent. Great stress is laid on loyalty. Drill and military training is a feature of all higher schools. The wearing of a distinctive uniform is very general in schools in Japan. The development of agricultural schools has been very rapid and in consequence many of the teachers are not well qualified, but on the whole I was much impressed with the headmen in all the schools visited.

In the short time at my disposal it was impossible to go into every detail, but the above is sufficient to show the great importance attached to elementary training in agriculture, a branch in which India at present is gravely behindhand. In America also a great deal was being done in elementary agricultural education, but I had no time to see any schools. I saw Texas and California State Colleges: they were doing good work and have courses very similar to our vernacular courses, besides the ordinary degree classes.

Agricultural improvement.

A great deal of work is in progress in Japan on rice—mainly varietal work. Some thousands of varieties seem to be grown and the subject is a difficult one. It seemed to me to be tackled on sound lines in most places.

Reorganization of holdings. Here is the most conspicuous success of this nature I came across. Already over 10 per cent.

of rice land has been readjusted into regular and compact holdings. To secure readjustment a majority of the farmers in any tract must be in favour. Formerly two-thirds majority was necessary, but the benefits were so soon realized that at present only a bare majority is required. Various bounties are given and certain remissions of land revenue to encourage the practice. A good deal of proselytizing goes on also and a persistent campaign is conducted in favour of it.

VETERINARY RESEARCH: SOME RECENT CONTRIBUTIONS.

EPIZOOTIC LYMPHANGITIS.

BOQUET, NÈGRE, AND ROIG.—FIRST ATTEMPTS TO PREPARE A VACCINE AGAINST EPIZOOTIC LYMPHANGITIS. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

Hitherto it has not been possible to prepare a vaccine against epizootic lymphangitis because it has not been possible to obtain cultures of the parasite in series. The authors have obtained some cultures from Rivolta which have enabled them to make some experiments in this connection.

They have ascertained that animals that have been affected for a period of fifteen days or have recovered from the disease yield a serum that is rich in antibodies, and further that recovery from natural or experimental infection confers immunity.

It has also been observed during the treatment of the disease with sterilized cultures of the parasite that in the benign form the disease is checked after the fourth injection. The authors have, therefore, been led to try heated cultures as a vaccine.

For the preparation of the vaccine the growth obtained on the surface of Sabouraud's medium was first ground up in a mortar dry and then emulsified with salt solution, the salt solution being added in the proportion of about 30 c.c. to 20 cg. of culture.

The vaccine so prepared was sealed up in tubes and heated to 62°—64°C. for an hour.

Four injections of 5 c.c. each were given subcutaneously on the side of the neck at intervals of eight days.

Four horses were inoculated in the manner described without producing any lesions beyond a slight transitory swelling. Eight

days later two of the animals were inoculated subcutaneously with 4 c.c. of emulsion of culture which had not been subjected to heat; after a period of incubation of four to six weeks there developed in these animals either a generalized lymphangitis or a localized lesion at the point of inoculation.

No healthy horses were available to use as controls, but two rabbits were inoculated with the same culture as the authors had previously found that inoculation of rabbits leads to the formation of a local lesion.

The two horses vaccinated but not inoculated with living culture were kept under observation for three months without showing any symptoms of infection. It is, therefore, concluded that heated cultures can be injected with perfect safety.

Of the two horses which received both vaccine and culture one developed a sterile abscess at the seat of inoculation, and at the seat of inoculation in the other there developed a small nodule about the size of a pea, which disappeared eventually.

Both of the control rabbits developed abscesses in which cryptococci could be found, thus proving that the cultures had not lost their vitality or pathogenicity.

All the vaccinated animals were mixed haphazard with seriously affected animals, yet none of them contracted the disease.

The authors state that they do not draw any definite conclusions from their experiment, but state that it does indicate the possibility of inoculating against the disease with sterilized cultures, and that the investigation will be repeated.

NÈGRE, BOQUET, AND ROIG.—THE MYCOTHERAPY OF EPIZOOTIC LYMPHANGITIS. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

In this paper the authors record their first attempts at treating cases of epizootic lymphangitis with vaccines prepared from artificial cultures which they have been able to obtain of the organism.

The vaccine was prepared in the same way as has been already referred to in another abstract dealing with the same subject taken from the same journal.

The vaccine was injected at intervals of eight days, and the initial dose was 2 c.c. The successive doses were increased by 1 c.c. up to a maximum of 5 c.c. which dose was not exceeded.

The injections were made on the side of the neck and the horses treated were not subjected to any other treatment; abscesses were not even evacuated.

In all, fourteen horses were submitted to treatment, but of these four could not be given the full treatment owing to difficulties of communication.

Of the ten animals which received the full course of treatment, eight made complete recoveries, while the remaining two which were the subject of severe disease of long standing died of intercurrent disease during the treatment.

A detailed statement of the ten cases is given, and these are divided into two groups according to whether there was cording of the lymphatics or not.

From the description of the detailed cases it would appear that in practically every case the injections of the killed vaccines caused abscess formation, and that recovery resulted in from one to three and a half months.

In a summary of the immediate results of the inoculations it is stated that during the first 24 hours there develops at the seat of inoculation a hot painful swelling about the size of the palm of the hand or a little larger. This swelling disappears in three or four days, but the area is still painful for several days longer. There is also a febrile reaction on the day following the injection, which lasts for two or three days.

NÈGRE AND BOQUET.—THE CULTIVATION IN SERIES AND THE DEVELOPMENT OF THE PARASITE OF EPIZOOTIC LYMPHANGITIS. *Ann. Inst. Past.*, Vol. XXXII, No. 5, May, 1918.

This long paper does not lend itself easily to summarization in a brief manner; a translation of the general conclusions drawn by the authors is, therefore, given :—

Pus containing cryptococci, taken aseptically from an unruptured bud and sown out upon an agar medium made from

horse dung and covered with a maceration of equine gland tissue, yields visible colonies which can be transplanted upon the same medium or upon Sabouraud's agar at first with and subsequently without the gland maceration. (Details of the preparation of the dung agar and the gland maceration are given in the body of the paper.)

With successive subcultures the cultivation of the parasite becomes more easy, and it develops more rapidly. After a number of passages it can be transplanted on to various media containing agar, gelatine, potato and carrot.

The optimum temperature for cultivation is 37°C. At this temperature the colonies upon Sabouraud's agar have a sandy yellow colour. They are wrinkled, and scattered over them are a number of little downy white spots. This downy appearance is more pronounced at lower temperatures.

When first sown out the cryptococcus becomes swollen and rounded, and drops of oil make their appearance in its interior. It then develops double contoured mycelial threads which produce external spores.

In subsequent subcultures the young colonies are composed of septate mycelial tubes with thin walls.

In older colonies these filaments disappear after having produced external spores by a process of budding. The latter give rise to septate mycelial tubes with a double contour and to chlamydospores. They are identical with those which arise by a process of budding from the rounded forms of the cryptococci.

The rounded form of the parasite as it occurs in primary cultures and the external spore are therefore the points of origin of exactly similar thread formations, and it would appear that the cryptococcus is the form of multiplication within the body which corresponds to the external spore.

We have established the fact that the parasite is able to multiply in the horse's skin in the form of the threads referred to above—that is to say, as tubes showing a double contour and external spores. According to one of our observations, which requires confirmation, the cryptococcus is developed in the horse's skin by a process of

budding from the external spore. At the moment when budding takes place the spore has only a thin wall.

In old cultures the segments of the mycelial tubes become detached from each other and have a twisted appearance.

Horses inoculated by scarification or intra-dermally with cultures of the parasite develop abscesses containing the cryptococcus. Subcutaneous inoculation results in the formation of abscesses which may subsequently become generalized by way of the lymphatics, thus producing the clinical picture of the natural disease.

Cryptococci appear in the lesions from three to four weeks after inoculation. They are at first free and appear as small ovoid bodies with thin walls. They then acquire a double contour, and the majority of them are to be found within the leucocytes.

The serum of diseased animals gives a positive result by the fixation test with cultures of the parasite. Antibodies can be shown to be present in the blood about the twentieth day after the disease makes its appearance. They persist for a long time after recovery.

A horse which has recovered from a primary attack of lymphangitis is resistant to a second inoculation with culture.

To sum up, we have succeeded in obtaining the development of the cryptococcus in the mycelial form. We have been able to obtain cultures of the organism in series.

We have established the multiplication of the parasites in the horse's skin in exactly the same form as in cultures.

We have reproduced the disease experimentally by inoculation with cultures and have shown that the cryptococcus makes its appearance and develops in the lesions produced.

We therefore think that the cryptococcus is the multiplication form within the horse's body of the organism which we have described.

The parasite will only be able to be classified when its sexual method of reproduction is accurately known.

RINDERPEST.

YOUNGBERG.—THE IMMUNITY TO RINDERPEST OF NELLORE (INDIAN) CATTLE AND OF VARIOUS NELLORE–NATIVE GRADES. *Philippine Agricultural Review*, Vol. X, No. 4, 1917. (Ex. *Trop. Vet. Bull.*, Vol. VI, No. 2, 1918. Original not available.)

It has been found that Nellore cattle adapt themselves readily to the conditions in the lower altitudes of the Philippine Islands and that when crossed with Native or Chinese dams a good type of animal is produced.

The idea was prevalent among Philippine breeders that the immunity possessed by Indian plains cattle to rinderpest could be transmitted to half-bred progeny. The author produces evidence both from field and experimental sources which shows that this is not the case.

The following conclusions are drawn up :—

(1) The pure Nellore cattle are very highly resistant to the Philippine strains of rinderpest, the mortality being insignificant. They are not, however, absolutely immune.

(2) In the case of Native cattle the infectivity of the virus is not appreciably attenuated by being passed through Nellore cattle. This fact makes the latter very dangerous as conveyors of disease, as they may react without showing clinical evidence.

(3) The half-bred Nellore cattle do not inherit the high degree of resistance to rinderpest possessed by the Nellore stock. In infections of moderate virulence they apparently have somewhat more resistance than the Native animals, but in virulent infections this resistance does not afford them any protection.

(4) From the inconclusive evidence at hand, the three-fourths Nellore-Native grades appear to have a greater resistance than the Native stock.

(5) The rinderpest problem of the Philippine Islands cannot be solved by the importation of Nellore or other Indian cattle unless possibly by carrying it out to the extent of practically eliminating the Native stock.

PARASITOLOGY.

CHATTON.—MICROFILARIA OF THE DOMESTIC CATS IN SOUTHERN TUNIS. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

The parasite figured and described in this note was found in two out of twenty-six cats examined.

In one of these they were scantily present in the blood at post-mortem, and in the other fairly numerous.

There is no information as to whether the parasite is present periodically in the blood.

The parasite appeared to be devoid of any sheath. In preparations fixed with osmic acid, it ranged from 240 to 350 microns in length, and from 7 to 9 microns in thickness. In view of the fact that the longer parasites were thinner than the short ones, it would appear that the differences in thickness were accounted for by contractions. The anterior end was obtuse and the posterior very slender.

There was no discoverable striation of the cuticle. The author thinks that the parasite bears some resemblance to *Filaria imitism* which is known to occur in Tunis.

YAKIMOW, SCHOCHOS, KOSELKINE, WINOGRADOW, DEMIDOW.—MICROFILARIASIS OF HORSES IN TURKESTAN. *Zeitschr. f. Infektions Krankh. etc. d. Haustiere*, Vol. XVI, No. 4, 1915. (Ex. *Trop. Vet. Bulletin*, Vol. VI, No. 2, June, 1918. Original not available.)

Examination of horses in military and civil possession in Turkestan showed that the former were far more severely affected than the latter. The maximum percentage infected in military units was 37·6. The maximum discovered among civil horses was 8·1.

The symptoms presented were abrasions of the skin due to irritation, especially about the nostrils, œdematous swellings of the chest, abdomen and limbs, and in some cases rapid exhaustion and dyspnœa when the animals were put to work.

The hæmoglobin content of the blood fell to 60 per cent. There was very marked eosinophilia, lymphocytes were increased in numbers and polynuclear leucocytes showed a corresponding decrease.

The filariæ possessed a sheath which projected beyond both ends of the body.

The body of the parasite, which was rounded anteriorly and tapered posteriorly, measured from 159 to 267 microns; while the total length of the sheath ranged from 270 to 323 microns.

No diurnal periodicity was observed, and subcutaneous inoculations of infected blood into a horse, ass, and two sheep failed to produce infection.

Intravenous injections of salvarsan were without effect.

The authors believe that this parasite differs from those previously described as occurring in horses and suggest the name *Microfilaria ninæ kohl-yakimovi* for it.

MOUCHET.—SOME ANATOMICAL LESIONS PRODUCED BY NEMATODES. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

The author describes in this paper some lesions which he found in the organs of a leopard which had been poisoned with strychnine on account of the depredations it caused among goats at Kangomba (Tanganyka).

The whole of the intestinal wall starting from a point 20 centimetres from the stomach to a point 30 centimetres from the cæcum was scattered with nodules which numbered about a hundred. They projected from beneath the serus membrane, were about the size of peas, and were of a bluish colour. The nodules were cystic and the walls were from two to three millimetres in thickness. Inspection of the mucous membrane showed that the cavities of the cysts communicated with the lumen of the intestine by small openings about one millimetre in diameter. Each of the cysts contained several worms from one to two centimetres in length. A small number of the cysts appeared to have no orifice leading into

their intestines, this was particularly the case with the smallest of them.

The worms were identified by Railliet as *Galoncus perniciosus.*

VAN SACEGHEM.—GASTRODISCUS ÆGYPTIACUS (COBBOLD, 1876). *Bull. Soc. Path. Exot.*, Vol. XI, No. 5, May, 1918.

Although the author's observations are incomplete owing to his having been compelled to leave Zambi where he was working, he gives the results of some of his investigations.

The eggs of *Gastrodiscus ægyptiacus* are easily discoverable in fresh fæces of infected animals. They measure 150 to 170 microns in length by 90 to 95 microns in width.

Apart from a polyhedral shaped mass in the centre the eggs show no evidence of segmentation at the time of laying. After three weeks' exposure to a temperature of about 28°C. (the average temperature of the laboratory) the contents of the eggs become very granular.

Segmentation takes place whether the eggs are kept in a liquid medium or not. After some days a little vermicule is visible in the egg. This executes intermittent movements and is ciliated.

The miracidium having escaped from the egg maintains its vitality and executes rapid movements if the escape takes place in water. If moisture is not present it rapidly dies. The larva measures about 160 microns in length by 73 microns in width. The anterior extremity is rounded and not pointed as in the case of the miracidium of *Fasciola hepatica.* In view of the facts that enormous numbers of horses harbour this parasite in very large numbers, and that a country very rapidly becomes infected with the parasite, the natural conclusion is that the intermediate host of the parasite, if one is necessary, must be an extremely commonly occurring one. The author thinks it is probably a common mollusc.

The parasite is, as a rule, not responsible for serious disturbances of health, but it may assist in producing ill health in animals in poor condition.

Infected horses not infrequently suffer from colic, and the author has found tincture of opium with the addition of ether the best treatment for this.

Arsenic appears to be valueless for the expulsion of this worm.

The only prophylactic measure that can be adopted is to prevent horses drinking on marshy ground and feeding grasses cut in marshy places.

VAN SACEGHEM.—THE CAUSE AND TREATMENT OF GRANULAR DERMATITIS. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

According to the author of this paper the cause of summer sores is the larva of *Habronema muscæ*.

Some larvæ of *Musca domestica*, which had been bred in the laboratory, were placed in the dung of a horse known to be infected with *Habronema muscæ*.

Seventy per cent. of the flies which developed from these larvæ were found to be infected with the larvæ of *Habronema muscæ*.

This infection takes place during the larval stage, but not during the nymphal stage.

The larvæ of *Habronema* are capable of surviving for 12 hours in a liquid medium. If they are placed on the hair, or on a shaved area of skin of a horse, they show no tendency to pierce the skin, but if placed on lesions covered with serum they show a great tendency to penetrate.

The author has observed small parasitic nodules on the membrana nictitans and has produced the same lesions experimentally.

Treatment is both prophylactic and curative.

The administration of arsenic in doses of 1 to 2 grammes daily should, in the author's opinion, be beneficial in destroying the larvæ in the horse's stomach.

Since the larvæ are rapidly destroyed in manure heaps which are generating a good deal of heat, it is possible to reduce the chances of infection by burying the fresh dung daily in a fermenting heap.

By this means both the larvæ of the worms and of the flies which are likely to become parasitized may be killed.

During the hot weather all wounds should be dressed with dry powder dressings.

As a curative dressing for wounds already infected, the author advises a powder composed of "plaster" 100, alum 20, naphthaline 10, quinine 10 or some other bitter powder. Such a powder keeps off flies, is very adherent, causes rapid drying of the wound, and on account of its bitter taste prevents the animal from biting itself.

TRYPANOSOMIASIS.

SERGENT Ed. AND ET., FOLEY AND LHÉRITIER.—THE MORTALITY IN EL DEBAB TRYPANOSOMIASIS OF THE DROMEDARY. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

According to Algerian camelmen El Debab in the dromedary runs a course ranging from some months to several years, and usually terminates fatally.

The authors have had under observation a couple of naturally infected animals. Both died four months after infection.

An experimentally infected dromedary appeared to have made a complete recovery after one and a half months.

It is pointed out that bad management is not infrequently a predisposing cause of death among infected animals. On the other hand, the absence of clinical symptoms often leads to the death of animals being attributed to bad management, whereas they are in reality infected with trypanosomes.

About 10 per cent. of Algerian dromedaries are infected.

VELU.—OCULAR AND LOCOMOTOR DISTURBANCES IN EQUINE TRYPANOSOMIASIS IN MOROCCO. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

Lesions of the eye, while fairly constantly observed, have not the same importance as the disturbance of the locomotor apparatus.

The conjunctiva may be distinctly yellow, but this is sometimes masked by congestion. Petechiæ of various sizes are present. These are at first red in colour but subsequently acquire a purple tint.

The eyelids are œdematous and the eyes half-closed. There may be erosion of the conjunctiva associated with profuse lachrymation.

These lesions may be present in varying degrees of severity. The locomotor disturbances are by far more constant, but these also vary in severity from case to case. They range from mere weakness, which is usually more pronounced in the hind limbs, to actual paralysis.

On a number of occasions the author has observed complete inco-ordination during febrile attacks. In every case in which locomotor disturbances have been pronounced, there has been incontinence of urine.

MISCELLANEOUS.

McCulloch.—The Stability of an Alkaline Hypochlorite Solution. *Jl. R. A. M. C.*, Vol. XXX, No. 5, May, 1918.

The experiments detailed by the author of this short paper were carried out with the object of ascertaining the value of an alkaline hypochlorite solution as a sterilizing agent—such a solution having been put on the market as an efficient water sterilizer. The experiments were carried out at Wellington, India. The author concludes that a solution containing calcium hydroxide, calcium hypochlorite, and sodium hypochlorite, with an average amount of available chlorine of 3·5 per cent., of which 0·35 per cent. was in the free state, is not much more stable than bleaching powder and is of little value as a stable sterilizer in tropical countries.

Selected Articles.

SILK AND SILKWORMS IN THE FAR EAST.

Being information gathered during a recent visit to China, Japan, Korea, Manchuria, and French Indo-China.

BY

COMMISSIONER AND MRS. BOOTH-TUCKER.

I. SOUTH CHINA.

Canton. The Canton variety of silkworm is a multivoltine, producing crop after crop in quick succession all round the year. It is closely related to the Mysore silkworm, and produces small cocoons but with a very good quality of silk. The cocoon is not worth exporting, except in the case of pierced cocoons which are exported as waste silk. The price when we were at Canton averaged about 83 dollars per picul of 133 lb.

In regard to colour of cocoons and silk, this varies. There are some which are the same light greenish colour as the Mysore and others which have the rich yellow of the Bengal, but the bulk are pure white, and only the last mentioned are used for producing reeled silk for export.

There are large filatures engaged in reeling this silk which is eagerly bought up by foreign merchants.

A very large proportion, however, of the cocoons are reeled and made into silk fabrics in China.

There are a number of small weaveries in Canton working with Chinese handlooms of a very ancient pattern. The work turned out is, however, excellent.

It was noteworthy that a great deal of the raw silk is put on the looms without being bleached, the fabrics being bleached afterwards. On the other hand, a good deal of the raw silk is bleached before being put on the looms.

On some of these old-fashioned looms patterns of beautiful design are worked by means of a very ingenious " Jacquard " arrangement, if so it may be called, a weaver sitting above the loom and pulling an intricate number of threads to work the healds. No arrangement appears to have been made in Canton for introducing the much more simple Jacquard attachments, although the present plant certainly produces very satisfactory results.

The Silk Expert who kindly assisted us in our enquiries and who had had eight years' experience in the country, told us that he did not know of any school in South China for the instruction of the Chinese in superior methods of either rearing worms, reeling silk, or weaving, but the industry is so extremely ancient and the Cantonese are so very painstaking and careful in attending to details, that the whole industry is carried on with great success both as a cottage industry and otherwise. Recently, however, large filatures have been organized on the European model, and these appear to be very prosperous.

II. North China.

We visited Shanghai, Pekin, and Mukden, and made enquiries at various centres. Here we found three excellent varieties of cocoons, namely, Wusih, Shewshing and Hupeh. Experts whom we consulted told us that, in their opinion, the Wusih and Shewshing, which are white cocoons, are superior in quality to the Italian.

The extreme care and attention which is given by the Chinese to the cultivation of their silkworms, and the long period that the industry has existed will account for its great success. Government is now taking considerable trouble to establish silk schools in different parts of the country, so that improved methods may be introduced.

We were able to get a supply of Wusih and Shewshing eggs forwarded to us and have hibernated them in Simla and are sending them out to various centres throughout India, as well as to all Government institutions with which we are acquainted. This we are doing free of charge although the experiment has cost us a good deal, as we are satisfied that one, if not both, of these varieties,

may be of extreme value to us in India and may be better suited to the climate than either the French or Italian varieties. We have asked the different centres to which the eggs are being sent to kindly report the result. The North China cocoon harvest is in June and July in the hot weather, and hence it is probable that this kind of silkworm would be well suited to India.

The North China silkworms are univoltine and the cocoons, as in the case of other univoltines, are far superior to the multivoltines of South China.

We may here remark that the univoltine variety has one great advantage over the multivoltine, inasmuch as its care does not interfere with the growing of the ordinary crops. It is usually produced at a time when agricultural labour is, comparatively speaking, free, and helps to supplement the revenue from other crops without interfering with them.

In making investigations on this question in France and Italy, experts there said to us that they did not care to introduce multivoltine varieties into Europe because it was found that they interfered with other and more profitable crops, which was not the case with the univoltine. This is a point which should be borne in mind. The agriculturist naturally looks for profit and the introduction of a crop which pays better than silk has been known in some localities to lead to a wholesale destruction of mulberry trees, as was the case some years ago in parts of Italy.

There is an immense demand for the above three kinds of cocoons in the Chinese filatures and high rates prevail so that the cultivation is extremely profitable to the people. The Yang-tse-Kiang river forms a splendid highway for their transportation to the filatures on the coast, and this, in the absence of railways, helps in the production.

Both the Shewshing and Wusihs are pure white cocoons, while the Hupehs are a rich golden yellow. The Hupehs appear only to have been recently introduced to the filatures and were at first looked upon as inferior. In fact reelers in some of the filatures refused to use them, showing how strong is the feeling in China in favour of white cocoons as opposed to yellow. It was necessary

in some of the filatures to begin with two or three basins and gradually work up others.

The Wusihs are produced in a flat level country very like Bengal or the Gangetic valleys, the summer heat being very great. The Shewshings are produced in a somewhat hilly country at an elevation of about one thousand feet. The Hupehs come from the interior of China.

The mulberry is mostly planted in the form of dwarf trees two or three feet high, planted very close. Lately bushes have been introduced, but as a rule only one or two stems are allowed to grow, and these are cut down yearly. The leaves are stripped off and fed separately, and the worms are reared on large round trays. The custom for cocoonage, *viz.*, for the mounting of the silkworms to produce cocoons, is to place bundles of grass, tied at the bottom with their heads spread out. Women gather the worms in baskets when they appear to be ripe and go round placing them on the top of the bundles of grass to spin. The method is somewhat primitive, but answers its purpose.

Another plan is to have a long straight rope with flat stars inserted at intervals on which the worms are cast to spin. They are not encouraged to "mount" of their own accord.

The Chamber of Commerce and the French Consulate in Shanghai are endeavouring to introduce improved methods amongst the rearers.

The filatures are quite up-to-date, and the basins which we saw had five, six, and even eight buttons working. Women are mostly employed in doing the reeling, while men supervise and watch the work.

It is not found necessary to re-reel, as the reeling itself is extremely good. In a filature which we visited we were told that all the raw silk they produced was marked as 100 tavelle, that is, without any breaks, while the variation in denier was merely fractional. At the time of our visit this raw silk was fetching 7 American dollars per pound (not kilo.), equivalent to Rs. 21 per lb.

Where large numbers of buttons are worked, the cocoons are prepared for the reelers by girls and the breaks are mended by

separate women who are employed for the purpose. It is a little remarkable that they are paid by the day and not by results. If, however, they do not produce a fair day's work, they are fined. Owing to the high price of raw silk and the strong demand for it, the number of filatures has enormously increased of late.

The godowns for storing cocoons which we visited were nothing like so up-to-date as those which we visited in Srinagar. They are a good deal troubled with rats in the godowns, but rely on cats and traps for keeping these down—they are not able to use poison. The raw silk was packed with extreme care and not in the apparently rough and ready manner which prevails in Kashmir.

Silk-weaving in Pekin. We visited a very interesting weavery in Pekin which was much more up-to-date than the weaveries of Canton. They had imported Jacquard attachments for their hand-looms from Japan, and these were being very successfully worked, many excellent fabrics being produced.

Everywhere, both in South and North China, one could not help being impressed with the fact that the enormous production of cocoons in the country facilitated the manufacture of cheap silk fabrics, and that in this respect India could not hope to compete with either China or Japan till she had established a sufficient production of cocoons. The success of the industry was based on the existence of the raw material.

III. MANCHURIA.

Manchurian tussor. Authorities claim that the cultivation of the Manchurian tussor preceded that of the domestic variety. The rearing area which originally occupied the Peninsulas of Liaotung and Shantung gradually spread eastward to the valley of the Yalu, Chefoo and Antung, being now the principal commercial centres.

Operations were considerably interrupted by the Chino-Japanese and Russo-Japanese wars. But since their conclusion the industry has advanced with extreme rapidity.

This variety of tussor feeds on four kinds of silkworm oak. The system of growing these in dwarf plantations appears to

be well worth considering for application to the Indian tussor and muga.

The trees are planted by the Chinese about 3 to 5 feet apart, about 12,000 acorns being planted to the acre. Holes are dug about 6″ to 1′ deep and several acorns are placed in each. They are not manured. They sprout in spring, and the weaker growths are then removed. After two or three years there is a fair growth, and they are then cut back usually to the height of a foot and are used for feeding the following spring. The trees are never permitted to exceed 5 or 6 feet in height.

There are two methods of pruning adopted :

1. The umbrella method, in which the tree is pruned to a height of two or three feet above the ground in the shape of an umbrella.

2. The tree is cut down at about one inch from the roots, sending out new shoots with dense foliage the following spring.

The pruning is carried out after the gathering of the autumn crop.

A well regulated plantation will include trees of various ages, the youngest or recently pruned being reserved for young worms, and those with more mature foliage for older worms.

The trees have to be renewed from time to time as the leaves become small, hard and unsuitable for feeding.

In the new districts trees are propagated by cuttings rather than seeds. Branches are selected from a growing tree, about 1″ in thickness and 3′ in length. Late in the autumn these are inserted in the ground to a depth of 9″. They sprout in the following spring, and 3 or 4 worms can be reared on them, the number being increased to 12 and 20 in the following two years.

The droppings from the worms manure the trees and increase the supply of leaf.

The dwarf plantation has the great advantage that the worms can more easily be removed from tree to tree, and protected from their bird and insect enemies.

There are two crops, of which the autumn one is the best.

There are several systems followed for hatching the eggs.

1. Indoors, the young worms not being taken out to the oak plantation until after the first moult.

2. After separation from the male moths, the females are taken to the plantation and tied to the branches of the trees till they deposit their eggs.

3. In Japan the eggs are kept in a box, and about ten days before hatching are pasted with starch to egg cards, each of which bears about 60 eggs. These cards are then fastened to the trees, and the paste prevents the eggs being washed off by rain.

When the eggs are hatched on the first system indoors, the young worms are fed on young branches of oak, two or three feet long, tied in a bundle and placed in vessels containing water, care being taken to prevent them from descending into the water and being drowned. This method is termed the "Han Tun."

Another plan is known as the "Shui Chang" or water yard. Branches are similarly cut and placed in the mud or sand on the banks of a mountain stream. In both cases care must be taken that the place is sheltered and not too exposed to the wind.

The above details show the extreme attention to detail bestowed by the rearers, both on the growing of the food tree and on the care of the worms, contrasting very strikingly with the careless, slipshod methods prevailing in India, and resulting in the rapid deterioration and destruction of what might become a valuable asset in her commercial, agricultural, and industrial prosperity.

For further information on this subject, see Norman Shaw's "Manchurian Tussor Silk," Fauvel's "Silkworms of Shantung," and Palen's "Wild Silkworm Culture in Manchuria."

At the same time it has to be remembered that the tussor silkworm cannot as a rule be compared from a commercial and profitable standpoint with the domesticated varieties, and it would in our judgment be a mistake to concentrate attention upon it in the present stage of the silkworm rearing industry in India.

The thread of the tussor is flat, making it difficult to combine with other fibres, while that of the domesticated *Bombyx* is round. It also lacks in brilliancy. The market likes it mainly if and when it can be obtained cheaply, and often, as in the case of the eri, at

"waste" rates, which may not pay to produce, and which cannot ordinarily compare with the prices commanded by mulberry silk.

IV. Japan and Korea.

In Japan we were very kindly received by Prof. Honda, President of the Imperial Sericultural Institute, who gave us much valuable information regarding the industry in Japan. This college has a staff of about 40 professors and teachers and is extremely well organized. Professor Honda himself has written a most excellent treatise on silk in Japan, containing a quantity of information which should be very valuable for use in India. We have supplied this book to our silk schools.

There is no doubt that the organization of the silk industry in Japan is far ahead of that in any other country. The Japanese are born organizers, and one has only to travel through their country to see with what care they collect the most exact details calculated to contribute to the success of the industry, and how lavish they are in their expenditure in doing for silk what no private individual or organization can do for it.

The college is a commodious building, wooden, inexpensive, very simple, covering nearly the whole ground on which it is located. At the time of our visit there were 200 students. The ordinary course for students covers two or three years, and those who were admitted must have certain educational qualifications.

In spite of the great heat at the time of our visit—it was in July—the worms seemed to be doing well in all stages with the thermometer going up daily to 90° and 95° Fahrenheit. They did not appear to suffer in any way; nor was there any attempt made to keep them cool beyond having them on the ground floor of a double-storied building with ample ventilation, while the leaf was kept in a cool cellar, damped, so as to prevent its losing its juiciness and becoming dry through the heat. The professor told us that all over Japan similar conditions existed, and that the worms there did not suffer from this extreme heat.

He informed us that throughout Japan the worms were fed on bush mulberry, and he did not consider it necessary to have tree

mulberry, but that there were a great many different varieties of mulberry—between two and three hundred in all—and some were far better than others and produced better results. Great care was taken moreover in feeding the young worms on young leaves and the older worms on matured leaves.

In travelling through Japan we noticed the absence of tree mulberry, and that in some cases instead of bush mulberry there were dwarf trees. We noticed also that the greatest care was given to the cultivation of the mulberry plants. The plantations were absolutely weedless, well manured and cultivated, and, in almost all cases, irrigated. Hence, in spite of the great heat there was a full and abundant supply of leaf which seemed juicy and tender. Again, instead of the poorest soil being given to it, as is so often the case in India, so far as we could see, the best and richest soil was being utilized for growing mulberry. Evidently, in the opinion of the Japanese, no soil was too good for the food of the silkworm. We asked the professor whether there was any special reason for preferring bushes to trees. He replied that trees were much more liable to disease, and hence the preference for bushes. It was much easier also to pick the leaves, and the bushes could be planted far more closely than trees.

Grainage. The utmost care is given to grainage, or the production of disease-free eggs. No one may produce eggs without a license, and a staff of something like 3,000 inspectors is employed in inspecting the licensees and watching that no diseased eggs are allowed to be produced. The ordinary rearer of silkworms was forbidden to grow seeds either for himself or for others.

Hibernation. The best way of storing eggs was, in the opinion of the professor, in windhalls, or caves, which were dug in the side of hills. Positions were found in the slope of a hill facing north, where there was reason to believe that there would be a natural current of air from inside, and here a *pakka* cave was made about 20 feet in depth right into the side of the hill. It was essential that there should be natural draught, hence the name "windhalls." Coming from inside, it secured a uniform temperature, throughout the hottest weather, of from 30° to 40° Fahrenheit. It was built

out of the hill with some sort of trellised doors so that the wind could get out freely all the time and play upon the eggs, which were simply arranged in shelves. Another system of hibernation was the usual snow-pit, while another was the artificial refrigerator. This last was very complex and expensive and did not appear to be particularly favoured by the professor, though one was in operation in the grounds of the college. He considered the windhalls were the most suitable. In these, eggs could be stored right through the hot weather. This was important as the Japanese have now two harvests of cocoons, one in the summer—the most important—and another in the autumn. The eggs for both are the univoltine variety and are the previous year's layings, being preserved in the windhalls till they are required for use.

This is an extremely important point for India, owing to the fact that in a great part of the country the mulberry produces its best supply of leaves after the south-west monsoon, and the regularity of this monsoon would probably enable a very good crop of cocoons to be produced at this time. At present the attempt to keep the eggs artificially till they are required at the end of the monsoon has not been a success, but the windhalls may get over this difficulty.

On the point of re-reeling, the professor told us that it was the universal practice in Japan to re-reel their raw silk. This was not in order to get the tavelle perfect, but because of the dampness of the climate. It was not necessary in China, and would not be in other places where the climate was not so damp as that of Japan.

In Korea the Japanese have made great efforts for the extension of the silk industry, and the prospects seem excellent. [See Japanese official report on the administration of Chosen (Korea).]

It is important to note that in Japan, from the Emperor's household downwards, the whole country takes an interest in the rearing of silkworms.

I. The Empress herself has a mulberry garden inside the palace grounds and cultivates silkworms with a view to encouraging the industry.

II. The Government also throws itself heart and soul into the industry—

(*a*) Sericultural Institutes. There are two important institutes supported by Government, one in Tokio and the other in Kioto.

(*b*) Prefectural Schools of Sericulture are also established in four different Prefectures.

(*c*) There are also thirteen Sericultural County Schools, besides many private schools.

(*d*) There are eight Prefectural Institutes of Sericulture and five County Institutes, while private institutes are innumerable, and there are a number of temporary institutes and training places opened during the rearing season.

(*e*) Agricultural Colleges, Forestry Schools, and Agricultural Experiment Stations give training in sericultural courses. These institutions, when not supported by Government, Prefecture, or County, are liberally subsidized by them. Subsidies are also given by Government for enlarging mulberry plantations.

(*f*) Circuit Lecturers are employed by Government, Prefectures, Counties, Towns and Sericultural Associations. They are sent round to give direct guidance and encouragement to those engaged in the industry. Some of these circuit lecturers are employed all the time, while others are only employed for the season. They are supplied from among the graduates of the above mentioned schools and institutes.

(*g*) Competitive Exhibitions. Numerous exhibitions are held in the different parts of the country to give encouragement to sericulturists, by collecting and exhibiting their products, thus giving stimulus for the betterment of the industry. Prizes or certificates of excellence are given. At least 50 such exhibitions are held annually.

(*h*) Precautions against silkworm disease. Special laws are passed and strictly enforced for the prevention of disease. The offices for the prevention of silkworm diseases number 132, while the staff thus employed amounted, in 1909, to 3,175 persons. The annual expense for this one purpose, paid by the Central or

Prefectural Governments, reached the vast sum of one million yen, say, 20 lakhs of rupees.

"Conditioning" of raw silk. Government has established a "conditioning house" by special act of legislature in Yokohama. This we visited. No charge is made by Government for conditioning the silk, but there is an ingenious arrangement by which this institution is entirely self-supporting. The actual number of tests performed in the Silk Conditioning House in 1908 amounted to no less than 97,723.

III. *Sericultural Associations.* In addition to Government support, numerous Sericultural Associations have been established. The Sericultural Association of Japan has as its honorary president and patron the Crown Prince, with 30 councillors appointed from amongst influential men in the sericultural circle. Its board of investigation includes many noted scholars and sericulturists throughout the country, while its membership has reached to 60,000. This Association has its branches in every Prefecture throughout the country. Another similar Association exists with a membership of 40,000. A third has a membership of 36,000. In addition to this there are—

67 Sericultural Guilds.
35 Silkworm Egg Guilds.
21 Raw Silk Guilds.
1 Silkworm Rearers' Guild.
2 Silkworm Rearers' and Silkworm Eggs Producers' Guilds.
5 Sericultural Guild Unions.
1 Raw Silk Producers' Guild Union.

Special laws have been enacted to assist these Guilds and have resulted in immense benefit to the members.

IV. *Co-operative Credit Societies.* Under the Co-operative Societies Act passed in 1898, 2,442 co-operative credit societies have been formed for sericultural purposes, being 57 per cent. of the total number of Industrial Co-operative Societies existing in Japan.

V. *Cultivation of Mulberry.* The total area of mulberry farms in Japan was, in 1907, 957,552 acres, being 7·44 per cent. of the total

cultivated lands in Japan and over 16·2 per cent. of the total farms. These are steadily increasing year by year. In the Prefecture of Gumma 31·5 per cent. of the cultivated lands are devoted to mulberry; in Yamanashi 30·2 per cent.; in twelve Prefectures the percentage ranges from 10 to 31 per cent.; in eleven others from 5 per cent. to 10 per cent.

Nothing is more remarkable than the extreme attention given to details so that a good foundation is laid for the superstructure. The methods of mulberry plantation are generally classified under four heads :—

1. Bush Plantation.
2. Dwarf Plantation.
3. Pollarded trees, similar to France.
4. Full-grown trees.

Each of them is scientifically and methodically adopted and mulberry diseases are carefully dealt with.

V. French Indo-China.

We spent a week in French Indo-China, calling at the ports of Haiphong and Saigon. Saigon is the capital of French Indo-China, and we had here the good fortune to obtain advice and information from the Director of Agriculture and Commerce, who is a keen enthusiast upon the subject.

It is extremely interesting to notice the policy pursued by the French Government in French Indo-China, and the changes which have been made by them as a result of their experience.

As might naturally be expected, they commenced by introducing the French univoltine silkworm, but found that in the warm climate of the tropics it suffered considerably. Attempts were made to cross it with the indigenous worm. These again did not prove very satisfactory. Finally Government Experts decided to devote themselves to the improvement of the indigenous polyvoltine silkworm, which is practically the same as the Canton and Mysore varieties. Here they have achieved great success.

They have devoted themselves to two points: one, the provision of disease-free eggs for the people. For this purpose small inexpensive rearing centres have been established in different parts of the country, and the disease-free eggs issued without charge by Government to rearers. No less than 6,272,500 layings of eggs were issued by Government to the rearers in 1914, and the demand for these eggs was double what Government was able to supply.

At the same time Government devoted themselves to the improvement of the indigenous silkworm, not by hybridizing, but by a careful system of selection. It is now a well-established fact amongst silkworm-rearers that the hybridizing of a well-established nationality of silkworms, if one may use the expression, by another nationality of quite distinct origin, is often unsatisfactory besides being extremely tedious. It is a very slow process, extending over many years, and there is a constant tendency to lapse. Where eggs have to be produced by millions, hybridizing can only work very slowly, and whilst there are many excellent breeds of worms in existence, it is doubtful whether commercially the thing is worth much time, trouble or expense. It ought to be done on a small scale for experimental purposes at Government Experimental Stations, but it should not be regarded as part of the Government commercial propaganda, seeing that the market requires large quantities of raw silk of *uniform* texture, not a hodge-podge of many varieties. This is an important point.

The French Government having devoted themselves to improving the existing indigenous worm, they have so far succeeded that the actual quality and length of fibre produced from some of these indigenous worms thus carefully treated, is almost equal to that of the best French varieties. This is undoubtedly a great triumph, but we may say that commercially it does not at present count for much, and it will be many years before it really makes a considerable difference. The fact, however, that this is being done with the indigenous worm and not with a hybridized lapsable variety is very much in its favour, and points very strongly to the policy which ought to be adopted by Government in India.

It must be remembered that all the prejudice of the French experts must have been in favour of their own very superior French silkworms, and that it has been only with reluctance, and gradually, that they have altered their policy to suit the tropical conditions of the Orient. The Director has a small silk school under his personal supervision in the Botanical Gardens at Saigon, and very kindly showed us all the details of it. Comparing this school with those of the Salvation Army in India, we could not help feeling gratified to find that it was being carried on along almost exactly the same lines as we had ourselves introduced. The whole object was to encourage sericulture, including reeling and weaving, *as a cottage industry*. There was nothing there which a native could not introduce into his own cottage, and yet every implement used was being improved. There was, for instance, very ingenious, simple, and inexpensive system for the silkworms to "mount" when forming their cocoons. This was to take the place of the ordinary *chandrika*, which is there employed very much as in India. There was also a very simple oven for drying the cocoons, the damp climate of the country making it difficult to do this by means of the sun, as is commonly done in India. The system was also much more satisfactory and quite cheap. The professor preferred the dry heat system to the use of steam. The "bassine à feu vu" for cottage reeling was not in our opinion nearly as good as our own Salvation Army Cottage Reeling Machine, nor was the cottage handloom to be compared with ours.

There was a mulberry garden in which different kinds of Tonkinese and Chinese mulberries were being grown, and careful experiments were being tried.

One of the points on which we made careful enquiry during our visit to the East, including China, Japan and French Indo-China, was the possibility of rearing multivoltine silkworms in tropical climates and in the plains similar to Madras, Bengal, etc., practically all the year round. It was quite evident that the indigenous multivoltine could be thus grown if proper arrangements were made for their food. We came to the conclusion that the success in this respect was largely due to the extreme care given to supplying the worms

with juicy leaves from irrigated mulberries, and that a good many failures in tropical climates are due to the fact that the worms have been badly fed and cared for, and that the proper conditions have not been sufficiently watched, while there has been no attempt anywhere made to cope with disease, which, as is well known, is of an extremely virulent character if not checked at the outset.

SCIENTIFIC PLANT BREEDING.*

So much attention has been directed to the purely scientific advance that has followed the birth of Genetics as a new branch of science that little regard has been paid to the very remarkable results already reached by the application of Mendelian methods to the problems of economic plant production. It is necessary to distinguish somewhat sharply between the facts which Mendel was the first to discover, and the hypotheses which have been put forward to explain these facts. The practical plant breeder is not primarily concerned with the theory of the subject; the Mendelian fact of grand importance to him is that unit characters do segregate, and that new combinations of these characters can be made.

It may be of interest, therefore, to consider some of the more important results obtained in regard to food-producing plants, and to indicate some of the difficulties which may impede future progress. Of food grains none is more important than wheat. The most marked achievement in wheat breeding is the production of a variety resistant, if not entirely immune, to the fungous disease known as Yellow Rust (*Puccinia glumarum*), as a result of the discovery that resistance to this disease obeys the Mendelian law of segregation. Once this was established it became a comparatively simple matter to transfer this character as an independent unit from the poor yielding Russian wheat "Ghirka," in which it was found, to a wheat suitable to the conditions of England. The variety "Little Joss," which was "made" in this way some ten years ago, is now well established in the Eastern Counties.

The possible economic value of this achievement becomes apparent if the enormous yearly losses caused by rust—perhaps not far short of 10 per cent. of the yield annually—are considered.

* Reprinted from *Nature*, dated 25th July, 1918.

Another economic character that can be controlled in the same way is stiffness of straw, a matter of importance in those parts of the country, such as the Fens, where a weak-strawed wheat becomes "laid" in wet seasons. It is interesting to learn that a short, stiff-strawed variety known as "Fenman" has recently been produced which is likely to be largely adopted in the Fen country. But the possibility of greater additions to the food supply of the country is now in sight. It is well known that wheat is commonly a slow-growing plant; sown in late autumn or winter, it is harvested in August. Barley and oats, on the other hand, come to maturity more rapidly, and need not be sown until spring. There are, however, certain varieties of wheat which can be sown in spring, but, unfortunately, their yield of grain is considerably less than that given by winter wheats. The result has been that under the ordinary conditions of farming in this country the area that can be sown with wheat is limited to that not occupied by a crop during winter. Barley and oats must be grown after "roots" because the latter are not completely off the ground until early spring. If, then, it were possible to make a spring wheat combining the character of early maturity with a yield approaching that given by winter wheat, the economic gain might be enormous, for, obviously it would be in the interest of home food production to curtail the area occupied annually by barley. If, then, we could add to the existing acreage sown annually with wheat only one quarter of the normal acreage under barley and oats, we should add probably 20 per cent. to the home-grown cereals available for human food. The possibility of making an improved spring wheat depends upon how far early maturity and yielding capacity are found to segregate. Apparently, there are indications that the former does, but the problem in regard to the latter is complex, depending for its solution on the clearing up of the difficulties that are encountered in dealing with quantitative characters, such as yield, as distinct from qualitative characters, such as colour of grain.

The questions involved are obviously of great economic importance, for it is the quantitative characters that often determine the economic value of a plant or animal. But it is not simply a

question of the universality of the Mendelian law. If, as some geneticists hold, the inheritance of quantitative characters is regulated by a complex of unit characters, the practical application of Mendelian principles becomes exceedingly difficult, for with any number of characters over three the number of possible combination of unit characters becomes generally too large to handle. And the difficulty does not end there, for, owing to environmental fluctuation, the comparative genetic behaviour of individuals cannot be disentangled, and the plant breeder is consequently driven to resort to purely empirical methods of selection. Nevertheless the fact that the exact nature of the laws regulating the inheritance of quantitative characters is still obscure may not seriously impede the work of the practical breeder. In fact, it has been found in practice that, provided desirable qualitative characters can be built up in the desired complex, the quantitative characters may be susceptible of improvement by selective methods of a more or less empirical nature.

But when all is said, scientific plant improvement in Great Britain has made only a small beginning, due, no doubt, in part to the general excellence of the varieties of economic plants now established in this country. The "Improvers" of agriculture and horticulture in the nineteenth century revolutionized the industry, and, as an outcome of their activities and influence, British seedsmen, largely by selective methods, effected very great improvements in economic plants. It is only comparatively recently that this country has fallen behind. Allusion may be made to the great advances achieved in Sweden as a result of the work of the Svälof plant breeding station. Denmark also is forging ahead, but, curiously enough, progress has not been remarkable in Germany, owing, perhaps, to the extraordinary cult of Darwinism which prevails there, and the consequent belief in the effectiveness of mass selection. In America considerable progress has been made from a scientific as well as from an economic point of view—notably in producing a cotton immune to the destructive wilt disease.

But if a striking object lesson of the successful application of new methods to plant production is needed, we must turn to

India.[1] Dating from the foundation of the Pusa Research Institute about the beginning of the present century, great developments in the scientific exploitation of Indian agriculture have taken place. Much credit is due to Lord Curzon, who, aided, it is now curious to recall, by the munificent bequest of an American (Mr. Phipps), founded a department which, it is no exaggeration to say, has added thousands, and will add millions, to the wealth of the country. India undoubtedly presented a fine field for the modern plant breeder. If we consider the immense variety of her plant products, their value either as food or in the arts and industries, and then observe that, owing to the absence of any skilled seed production industry, there is an uncounted number of identifiable races within each distinctive variety of economic plant, we can form some conception of the possibilities which even selection presents: superadding hybridization, it is difficult to assign any limits to the field that is opening out.

It would be impossible in the ordinary limits of space to give a detailed account of what has already been achieved, but some indication may be given of proved successes in relation to the more important economic plants.

Mention may first be made of wheat, of which upwards of 30 million acres are grown, and which was naturally one of the first crops to receive attention. Both selection and hybridization have been brought into action, and several new varieties are now firmly established. In the United Provinces in 1917 alone "Pusa No. 12" occupied 100,000 acres, and was extensively grown in the Punjab as well. This wheat gives a cultivator an *increased yield of 25 per cent.* over the varieties formerly grown by him, as well as nearly one shilling per quarter more on the market, owing to its improved quality. Another and later production of Pusa has on occasions given a yield of nearly fifty-five bushels per acre, which for India is an unheard-of figure, and may be compared with thirty-two bushels, the British average yield of wheat. In the Punjab another

[1] Report on the Progress of Agriculture in India for 1916-17. (Calcutta: Supdt. Govt. Printing, India, 1918.)

new variety occupied 97,000 acres, and it is estimated that the growers of this wheat were presented with an additional income of nearly 15,000*l*. In the Central Provinces improved varieties, returning to the cultivators considerably increased profits, occupied 200,000 acres. Remarkable progress is also being made in the production of improved varieties of rice, the most important cereal crop in India. A variety known as "Indrasail," isolated by pure line selection, occupied 20,000 acres in Bengal. In the Central Provinces it has been necessary to establish thirty seed farms for the production of other new varieties. Turning to non-food products, we find that extraordinary advances have been made in regard to cotton (of which 20 million acres are grown in India). In Surat an improved cotton has been produced giving a premium value of 13 per cent.; in Sind new varieties are giving a premium of 23 per cent. In the Central Provinces a new introduction is estimated to occupy no less than 800,000 acres, and to have brought the cultivators increased profits of nearly 900,000*l*. After this we may pass over such relatively inconsiderable figures as 215,000 acres under a new variety in the Punjab, but, for its human interest, mention may be made of one incident in a campaign directed to the eradication from a certain district of an inferior indigenous variety. It is a good example of the methods adopted to impress the Oriental imagination. "In the Tinnevelly District the department had to resort to drastic action for the control of seed in the case of some ninety acres of *pulichai* (the inferior cotton)......the seed from this cotton was publicly burnt......before a large gathering of ryots."

In the improvement of jute (of which India exports annually products worth £40,000,000) some notable advances have been made. It is expected that in the present year more than 30,000 acres will be sown with a new selected variety as a result of the distribution by the department of 500,000 packets of seed. In this connection a valuable scientific discovery may be mentioned. The pernicious weed, water hyacinth, which infests the waterways of Bengal, has been found to have a high potash content, and is consequently a valuable manure for jute, the use of which not only directly

stimulates yield, but also protects the plant against a *Rhizoctonia* disease which attacks it.

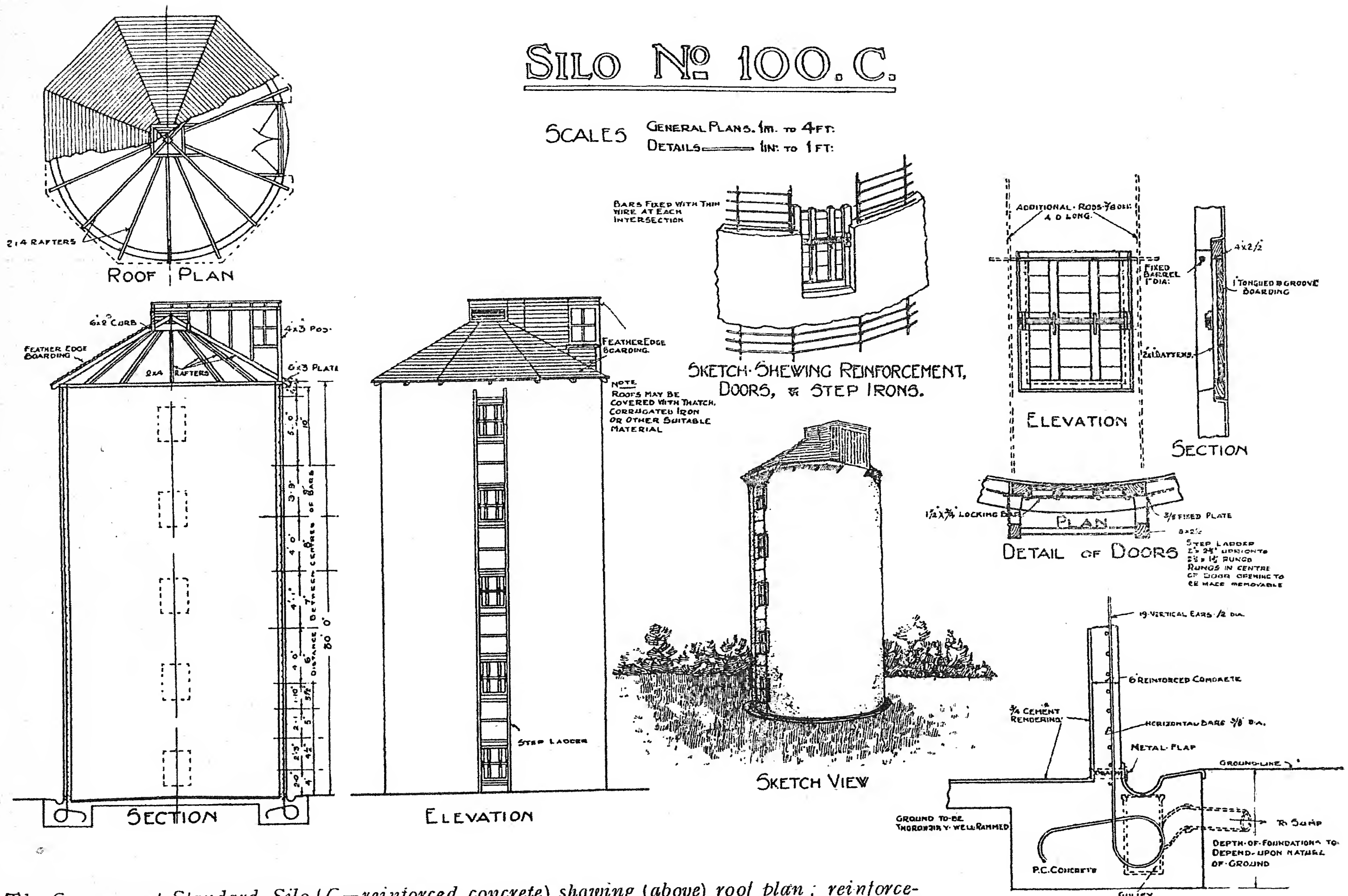
It will be readily admitted that this tale of economic progress is astonishing. No mention has been made of the purely scientific results achieved, and they are very considerable. The workers no doubt feel well rewarded by the satisfaction with which they must regard the additions to knowledge which they have made, but they may also feel some pride in the remarkable economic advances which their labours have brought about, especially in regard to the food-producing plants.

THE GOVERNMENT'S STANDARD SILO.*

Early in the present year (1918), on January 12th to be exact, we published a leading article dealing with the need for ensilage that must ensue from the conversion of so much pasture land into arable. Apparently it hit the nail on the head. There followed much interesting correspondence from those directly interested in this method of preserving summer herbage for winter food. Incidentally it disclosed great differences of practice and opinion. On one point alone was there unanimity. Every practical stock-owner felt that, as the contraction of grazing space synchronized with a serious and increasing scarcity and dearness of feeding stuffs, the silo must now enter on a new career of usefulness. Previously it had been the custom to discount its free use in Canada and the United States by pointing out that in these countries the length and severity of the winter compelled farmers to stable their livestock and feed indoors for a larger portion of the year than is necessary with us. But the circumstances arising out of the war caused them to drop this excuse for indifference. It was disclosed that to a greater extent than had been generally known those farmers who recognized that agricultural success depends upon taking long views had been quietly preparing to make ensilage. Enquiry on our part showed that the movement had been most pronounced in the Eastern Counties, where the root crop is very uncertain, and that Mr. Amos, whose successful management of the Downing College land is very well known, had given special attention to the subject. Fortunately, we were able to induce him to write a series of articles that proved to be valuable and instructive.

Meanwhile, the Board of Agriculture, through its Food Production Branch, had taken the matter up seriously. Previously the

* Reprinted from *Country Life*, dated 18th May, 1918.



The Government Standard Silo (C=reinforced concrete) showing (above) roof plan; reinforcement, doors and step irons: detail of doors—elevation and section—(below) section; elevation; sketch view; detail at foundation.

subject, without being ignored, had from time to time been agitated, but not in a manner that attracted much attention. At any rate, no successful attempt had been made to get silos erected on British farms. From time to time official articles had been published, calling attention, indeed, to the advantages of making ensilage and giving instructions how to set about it, but altogether lacking in workable proposals for translating academical teaching into the general practice of husbandry. But the question was now tackled in a more purposeful spirit. An expert was engaged to visit and report upon silos in actual operation. Conferences were held to compare and estimate the relative advantages of different types, and finally standard plans were drawn up and are now made available for all who wish to erect silos of their own (Plate II). They will be disseminated by a machinery originally produced to deal with war agriculture. In other words, the County Executive Committees are called upon to promote the object in view. Plans and specifications are to be placed on view in the offices of each Committee, open to inspection by all who are interested. Also a little pamphlet has been drawn up for distribution. This clear and concise document should prove most serviceable. Standing alone on the first page is the sketch of a reinforced concrete silo for one hundred tons, and on the next a corresponding sketch of the reinforced brick silo for holding fifty tons—the former suitable for a herd of twenty-five cows, and the latter for a herd of twelve cows. Then follow the terms of the offer made by the Department, which are five in number, and are offers of (1) expert advice; (2) free supply of full working quantities, drawings and specifications; (3) loan of form and centering (moulds) and facilitating use of permit for materials; (4) estimating for complete construction of silos at a fixed price; and (5) assisting with any type of size other than the standard one adopted.

In considering this very encouraging offer, it would be well, in our opinion, to keep two considerations in mind. Whatever arguments may be advanced in favour of a wooden in preference to a concrete or brick silo, do not affect the difficulty of obtaining the timber with which to build it. That is a difficulty which apparently has decided the Department to say nothing about this type of silo.

Again, a very large number of our correspondents wrote with admiration of the rough-and-ready stack silo which in many cases has been enough to serve the purposes of the holding. Now, a stack silo is better than none, and in these times a man often has to consider less what he would like than what he has at disposal. Therefore it would be wrong to discountenance any method of increasing the home-grown and home-preserved food for livestock. But the stack silo is very uneconomical for permanent purposes—it is attended by a too serious decrease in solids. Two very useful sizes have been chosen, one 15 ft. in diameter by 30 ft. in height, capacity 5,300 cubic feet, holding about 100 tons of ensilage. The other is 24 ft. in diameter by 24 ft. in height, with exactly half the capacity of the other. Each type can be built either in reinforced brick or reinforced concrete.

We must not omit some reference to the last page, which is filled with a table of advantages of silage, very tersely and clearly put, each point being a maxim in a nutshell. The first four refer to it being a means of preserving green fodder for the winter, being independent of weather, being more certain on heavy clay land than root crops, and being cheaper than root growing under unfavourable conditions. The next two are directed to the growing of silage as a catch crop or a cleaning crop; the last four relating to the economy of labour and time which is secured by the use of the silo. They form an excellent set of precepts, well fitted for their purpose, which is the dissemination among those who are in any way likely to wish to build a silo for their own use.

We have no doubt that the number of those who wish to do so will exceed what is possible this year, owing to the difficulties connected with labour and material. Every stock breeder, and especially the cattle breeder, will find that under the new system of agriculture now inaugurated and not likely to be given up or even to be radically changed in our time, the silo will be an indispensable adjunct to the farm.

AN IMPROVED TYPE OF COTTON FOR THE SOUTHERN MARATHA COUNTRY.

BY

G. L. KOTTUR,

Cotton Supervisor, Southern Division, Bombay Presidency.

COTTON is the most important crop in the black soil tract of the Southern Maratha Country, and covers an area of one to one and a half million acres in the districts of Dharwar, Belgaum, and Bijapur of the Bombay Presidency. The adjoining cotton-growing areas in the Madras Presidency and in the Native States of Kolhapur, Miraj, Sangli, Hyderabad, and Mysore present similar physical features and grow the same variety of cotton. The problems for solution in connection with cotton are therefore the same for the whole of this tract.

Except for a comparatively small area under Dharwar-American cotton, the whole of this tract grows a variety of *Gossypium herbaceum*, known in the local vernacular as *jowari-hatti*. It is botanically identical with Broach cotton, but agriculturally it differs in many points. It is a late sown cotton producing seedy *kapas* only one-fourth part of which is lint. The latter reaches the spinners under the name of Kumpta cotton. It is suited to spin 30's, and therefore ranks high in the list of long-staple *desi* cottons. We have in India few long-staple cottons, and the few that we have are in danger of being ousted by short-staple varieties. In the Southern Maratha Country, however, conditions are unfavourable to the growth of short-stapled varieties, and the tract is recognized as essentially a long-staple tract. Many other long-stapled cottons, both Indian and exotic, were tried in Dharwar, but

without producing any sustained success, and the only cotton brought from outside the tract that has survived the ordeal is the Broach cotton grown from Navasari seed, which has established itself in a limited area where conditions are favourable, and is still grown to the extent of a few thousand acres. Cross-fertilization also was tried, but out of a large number of hybrid cottons produced almost all have been finally discarded as unsuitable, and none has yet been regarded as suitable for introduction. Selection from the local variety was therefore the only method left by which improvement might be secured.

Now what are the characteristics of the local cotton (*jowari-hatti*)? It is sown in August-September, and is ready for the first picking by February-March. It is a stunted plant with a small average outturn of *kapas* per acre and a low ginning percentage (25%). The average outturn of *kapas* is taken at 320 lb. per acre, giving 80 lb. of lint. The staple, though long, is uneven and often weak. These defects gave an indication as to the directions in which improvement was indicated.

All *herbaceum* cottons produce a number of extra-axillary vegetative branches or limbs from the lower portion of the central stalk. These limbs take off from the main stalk at an angle of 45° and function exactly like the main stalk. At each node above the limbs, the main stalk bears two kinds of branches—(1) extra-axillary or fruiting, and (2) axillary or vegetative. The fruiting branch takes off at right angles from the central stalk, and at each node it slightly changes its direction of growth and produces a pedicel bearing a solitary flower. The vegetative branch behaves like the limbs, takes off at an angle of 45°, grows straight, and directly bears no fruits, but produces secondary fruiting branches. Now a study of the local cotton shows that there are two distinct types to be found, the erect type and the bushy type (Plate III). The erect type is characterized by the meagre development of limbs and vegetative branches. It grows tall and from each node produces a prominent fruiting branch. The bushy type, on the contrary, has from 5 to 10 limbs, and of its branches it is the vegetative ones that are prominent and vigorous, while the fruiting branches on the main stalk

Erect type Bushy type

Diagrammatic representation of the two types of *Jowari-hatti* cotton.
L - limb; F - fruiting branch; A - axillary branch.

are mostly suppressed and insignificant. In each case these characteristics are hereditary. The economic significance of this differentiation lies in the fact that it is the fruiting branches on the main stalk which first bear fruit, next the limbs, and last of all the vegetative branches. This difference would be immaterial if the environment were equally favourable to the reproductive activity of a plant throughout its growing period. But such uniformity is not obtained, for in the months of February and March there is a marked tendency for the late flowers to fall off. To secure yield, therefore, it is necessary to select the early flowering plants, that is to say, the erect type. Continued field tests have shown the superiority in yield of this erect type, and by sustained unit selection we have now got a plant which yields 12 per cent. more *kapas* than the local cotton; a *kapas* which yields 12 per cent. more lint than the local *kapas*, and lint which is valued at 5 per cent. more than the best Kumpta cotton available in the market.

The following report of Messrs. Forbes, Campbell & Co., of the Gokak mills, who kindly made the spinning test of our cotton, testifies its importance in the spinning industry of the future :—

"The cotton was considerably superior to any of the Kumpta cottons as supplied either direct or by the ryots or which we have obtained from the near markets. It is bright, light, clean, long in staple and uniform, and of middling strength. From it we spun three counts, *viz.*, 20's, 30's, 40's. The yarn ran smoothly and demanded very little attention from the work people, and we would no doubt have received better results, had we had sufficient cotton to make it worth our while to alter our machinery, so that it would be spun into yarn under the best conditions."

It is proposed to multiply and distribute seed of this improved type, and it is believed that by this means the economic condition of the cotton-growers will be materially improved and the spinning value of the Kumpta cotton will be enhanced.

CO-OPERATIVE SOCIETIES AND MARKETING OF COTTON *

BY

THE HON'BLE MR. PURSHOTAMDAS THAKURDAS, M.B.E.

IT is very usual to hear people swearing at cotton merchants on the ground that they buy *kapas* (unginned cotton) from cultivators very cheap and generally buy it before it is ripe to be marketed. In my written evidence to the Indian Cotton Committee I said as follows on the score of the cultivators' agency for marketing of *kapas* in the districts and on the score of the system of advances :—

" Regarding the system of the cultivators' agency for marketing of *kapas* in the districts, this also varies in various districts. The intelligent cultivator of the Surat and Broach districts does not, as a rule, employ an agent to sell or market his *kapas*. If he does not or cannot sell his *kapas* from his residence, he markets it himself and sells it off to the highest bidder on that day. He recovers the cash for it immediately. On the other hand, the ryot of the United Provinces or Khandesh sends his *kapas* to his *aratiya*, or commission agent, for sale and pays him a commission for the same. These *aratiyas*, wherever they are influential and wealthy, are *aratiyas* or commission agents for buyers also, and this dual capacity of theirs exposes them to a considerable temptation.

" *System of advances.* The system of advances to cultivators on their *kapas* divides itself into two chief parts.

" The first is advances against standing crops before the crops are matured and the other is advances against actual *kapas* when marketed. Regarding the first, this system is generally known as *jalap* and means the ryot estimating the outturn from his field and selling the same to the *sowkar* (money-lender) at a rate equivalent

* A paper read at the Co-operative Conference held at Bombay in April 1918.

to anything from Rs. 30 to Rs. 100 per *candy* (784 lb.) of cotton lower than the rate prevailing in Bombay. Against this sale the *sowkar* advances him 50 to 100 per cent. of the cost of the *kapas* so bought. The risk of such a buyer is twofold. Firstly, the risk of unforeseen ruin of the crop quantitatively, and, secondly, the risk of unforeseen damage to the quality of the crop by untimely rain or frost. This system was very prevalent twenty years back. The Deccan Agriculturists' Relief Act considerably discouraged this practice, but it still prevails to a fair extent.

"There is a good deal to be said against this practice of *jalap*. But in recent years when the prices of cotton may be said to have broken records of anything up to the last fifty years, the ryots themselves have shown great anxiety to avail themselves of rates which appear to them to be very high. All that could be suggested on this score is that co-operative credit societies should undertake what the village *sowkar* does, and should retain the margin for themselves in exchange for the risk that *jalap* operations entail on the buyer. As a matter of fact, I have not yet been able to comprehend why the various co-operative credit societies have not done so till now in their districts.

"The second mode of advances is the ordinary method of advances against *kapas* brought to the market, and I am not aware of any particular disadvantage to the ryot in this."

It will be perceived that as long as the Indian cultivator continues to be in a position where he must have money before the crop is ripe to be marketed in the normal course, some sort of accommodation is necessary for him. It need not be doubted that the *sowkar* giving him this accommodation makes the best of his opportunity to exact terms compatible with the risk he runs in making advances to the cultivator. I wish to suggest that people interested in the co-operative movement should turn their attention to replacing the *sowkar* or the cotton merchant with co-operative credit societies. It is well known that these advances to cultivators have to be made in the months of July to November when money is fairly easy everywhere, and it is not likely that co-operative credit societies will find any difficulty in securing money. What would be very necessary

to have is persons well-versed in cotton business to ensure that the co-operative credit societies' selling of cotton against a cultivator's *jalap* sale of *kapas* fetches the highest rate available either in that district or in Bombay with smallest risk regarding class, etc., to the seller. When this is organized it would mean that the cultivator selling his *kapas* would get that day's fullest market rate, and he would only have to pay interest until his *kapas* is actually delivered to the buyer. So much for improvement that can be effected in the cultivators' more or less necessary method of selling his crop before maturing.

Regarding the first paragraph of the quotation from my evidence given above, I think that even when crops are marketed after maturing, it is very necessary in some of the cotton-producing districts in India to have a co-operative credit society's agency for each day's *kapas* arrivals in each market. If this be organized with the help of reliable men on the staff of such agencies a lot of annoyance and petty losses to cultivators can be avoided, and looking to the increasing acreage under cotton all over India it would appear most necessary to organize such selling agencies in some of the important districts at least where there are no proper arrangements for independent weighment, etc., of the cultivators' produce. A good deal is being heard this year from well-meaning people not intimate with conditions and customs of the cotton trade regarding cotton merchants looting the cultivators. I have seen handbills asking cultivators in the district not to deliver *kapas* against their comparatively lower rate sales.

This is not the place to discuss the advisability or otherwise of such recommendations to cultivators, but this surely is the time to organize some sort of agency to keep cotton cultivators in good touch with the course of the cotton market in Bombay and abroad.

SUGAR AS A COAGULANT FOR *HEVEA* LATEX.*

BY

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Deputy Director of Agriculture, Planting Districts.

EATON and Grantham[1] found that if *Hevea* latex is allowed to stand in tall cylinders without the addition of any coagulant a slimy alkaline surface scum is formed, whilst the lower layers become acid and coagulation occurs in them. The surface changes are putrefactive in character and are brought about by organisms which are favoured by aerobic conditions.

The changes in the deeper parts of the liquid were considered by the authors to be due to activity of aerobic organisms. Both classes of bacteria were supposed to infect the latex after collection from the trees.

Whitby and Campbell showed that coagulation is not due to bacteria but to an enzyme, but that the putrefactive changes are due to bacteria, which by producing an alkaline medium, may destroy the enzyme and arrest coagulation in favour of putrefaction. Barrowcliff[2] brought forward a large amount of evidence to support this theory of coagulation and show that it was due to a specific enzyme.

In order to eliminate to some extent the predominance of the putrefactive changes and encourage the non-putrefactive ones, cane sugar and glucose were added to latex, and it was found that with each of these complete coagulation was obtained and

* Reprinted from the *Planters' Chronicle*, dated 10th August, 1918.

[1] Eaton and Grantham. *Agri. Bull., F. M. S.*, IV, 2 (1915). *India Rubber Journal*, LI, 10, p. 340.

[2] Barrowcliff. *Jour. Soc. Chemical Industry*, XXXVII, 3, p. 48T.

putrefactive changes were inhibited. With pure crystalline dextrose it was found that as small a quantity as 0·2 per cent. calculated on the latex, was sufficient to bring about complete coagulation within 18 hours, and this coagulation took place most readily in closed vessels filled with latex so as to exclude the presence of air. The dextrose was completely decomposed and the coagulum was full of bubbles of carbon dioxide. Similar results were obtained with cane sugar, lactose, arabinose, mannose, and lævulose.

Subsequent experiments showed that if the temperature was kept low, below 40° to 50°F., coagulation was inhibited, but if the temperature was allowed to rise to 84°F. coagulation became complete.

At a time when there was a shortage of acetic acid it was suggested in the F. M. S. that cane sugar might be used as a substitute. A number of experiments were carried out in Java and the result of trials made at the Central Rubber Station for testing was that the difference between rubber coagulated by acetic acid and that coagulated by sugar were insignificant.[1] Tensile strength, slope and viscosity are nearly always the same, but in the rate of cure a small difference is generally found, the sugar coagulated rubber curing slower or quicker as the case may be.[2]

This means that with a running sale contract the change from acetic acid to sugar would nearly always mean a change in the rubber delivered which, unless warning was given, must be considered undesirable.

On this point Dr. O. de Vries[3] issues a word of warning, namely, not to change the coagulant before being convinced that it will not change the quality of the product. He points out that a new coagulant may often influence the rate of cure and so inflict serious losses on manufacturers and again awake their former distrust of plantation rubber. Manufacturers are now accustomed to certain characteristics in plantation rubber and have arranged

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[1] Gorter and Swart. "Mededeelingen Rubber proefstation West Java, 6." *Agri. Bull., F. M. S.*, V (1916), p. 48.

[2] *Monthly Bulletin of Agri. Intelligence*, Rome, VIII, 10 (1917), p. 1421.

[3] *India Rubber Journal*, LII, 21, p. 744.

their treatment accordingly. A change in these characteristics without warning would be the cause of great trouble to them. A conservative policy is therefore advised by de Vries, who thinks that no change should be made before the peculiarities of the new coagulant have been thoroughly investigated. Every planter's ideal should be to sell his rubber under his own trade mark, by preference to one and the same buyer. This would be the surest way to fetch the highest prices and to obtain the best market. It will be obvious that such a customer would not be at all pleased at receiving unexpectedly a lot of rubber of different quality.

In general, however, and for the open market, the small difference in rate of cure can form no objection to sugar coagulated rubber. The difference is well within the limits which are generally found for ordinary first latex crepe. In three series of experiments the uniformity from day to day was not less with sugar coagulation than with the ordinary acetic acid coagulation.

The advantages and disadvantages of sugar as a coagulant may be summed up as follows :—

The great advantage is the cheapness of the material as compared with acetic acid, especially at the present time, while moreover it is always available in the country and does not depend upon shipping facilities. The quantity required is very small, 0·1 to 0·2 per cent. of sugar calculated on the latex, or one part of sugar to 500 parts of latex.

The disadvantages are first of all that it produces a product which differs slightly in rate of cure from acetic acid coagulated rubber, necessitating in the case of contracts a warning of the change to the buyers.

Another objection is that the coagulum is apt to be full of gas bubbles due to the evolution of carbon dioxide during the coagulation process, and sheet rubber suffering from this defect is looked on with disfavour in the market although the actual quality of the rubber is not affected by the presence of the bubbles. If crepe is being made, the bubbles of course do not matter, but sheet is chiefly made now.

Probably any drastic change in methods of coagulation likely to be adopted in the near future will tend towards what is known

as the M. C. T. process in which no coagulant is used at all, and by means of which a standard rubber can be made whatever the source of the latex.[1]

This process is based on the fact that in *closed vessels* latex coagulates completely without the addition of any coagulant and without putrefactive changes taking place. As carried out in practice, large cement tanks, provided with heavy water sealed lids, are used. Into these the bulked latex is poured, leaving the smallest possible air space above it. To each 100 gallons of latex, a quantity of calcium acetate equivalent to 4 oz. of calcium may be added if desired to accelerate the process. The covers are placed in position and sealed, and the whole is left undisturbed for three days when coagulation is complete. The resulting coagulum is converted into crepe in the usual way.

For the manufacture of sheet, iron pressure vessels are used, divided into partitions with aluminium sheets, and the coagulation takes place under a pressure of one or two atmospheres, which keeps the carbon dioxide evolved in the process in solution, and the resulting coagulum is free from bubbles and can be made into sheet.

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[1] Barrowcliff. *Jour. Soc. Chemical Industry*, XXXVII, 6, p. 95T.

Notes.

SELECTED CAWNPORE-AMERICAN COTTONS AND THEIR COMMERCIAL VALUATIONS.

In a previous number of this Journal[1] it was stated that, while Cawnpore-American cotton, as it then existed as a field crop, yielded well under irrigation and produced a cotton which found a ready market, there existed a considerable margin for improvement by selection in regard to yield, ginning percentage and uniformity of staple. The isolation of pure races was therefore taken up in 1912. Progress reports on this work have been given in the annual reports of the Cawnpore Experiment Station, and the detailed results are being published separately. As, however, a certain measure of success has been attained it may be of interest to summarize the main features here.

In 1912 a number of different types of Cawnpore-American cotton were selected from the field crop, selfed seed obtained (cross fertilization being prevented by covering the plants with mosquito nets), and the resulting progeny studied through several generations —with the necessary precautions to prevent crossing. In this way a number of races were obtained differing considerably in agricultural characters, in ginning percentage, and in lint. A large number of these races were discarded in the course of this work on account of unsatisfactory lint, low ginning percentage, excessive length of vegetative period, imperfectly hairy leaf (and consequent susceptibility to attack by aphis with the subsequent "red leaf" damage) or unsuitable habit. By 1916 a series of likely races had been obtained which were then tested for yield and ginning percentage on a field scale and for which, through the courtesy of Messrs. Tata & Sons, we were able to obtain commercial valuations of the cotton which were of the greatest value in deciding what types to retain.

[1] *The Agricultural Journal of India*, vol. VIII, pt. IV, 1913.

Through the kindness of Mr. Hodgkinson of the Indian Cotton Committee, arrangements were made for the valuing of several of these cottons, from the 1917 crop, in England, and the report of the expert brokers to the British Cotton Growing Association is as follows :—

	Per lb.	
"Ca 1	22·00 *d.*	Good colour, about good middling in grade, staple 1 to $1\frac{1}{16}''$. Rather mixed.
"Ca 5	21·50 *d.*	Rather dull, barely good middling, $\frac{7}{8}''$ to 1″ staple.
"Ca 7	24·50 *d.*	Good middling, strong and silky, staple $1\frac{1}{8}$."
"Ca 9	24·50 *d.*	Good ,, strong and silky, staple $1\frac{1}{8}$."
"Ca 11	21·50 *d.*	Good ,, good colour, 1″ to $1\frac{1}{16}''$ staple.
"Ca 18	24·50 *d.*	Good ,, good colour, $1\frac{1}{8}''$ staple.
"Ca 26	23·00 *d.*	Good ,, good colour, $1\frac{1}{16}''$ staple.

"All based on July American futures 22·00 *d.* per lb.

"Good middling American 21·56 *d.* ,, ,,

"The Ca 7, 9 and 18 are very good and are cottons which could be used extensively in Lancashire, and if India could produce any quantity, there should be an excellent demand. Of course you will understand that prices are abnormal and that it would not always be possible to obtain a basis of 250 points on for such cotton. Probably 70 to 100 points on would be nearer the mark. No. Ca 26 is also a good cotton, and could be used, but not to the same extent as the others. These qualities are, of course, a great improvement on the samples of Punjab-American 4 F."

As regards the order of merit of the various cottons, this report entirely bears out Messrs. Tata & Sons' valuations.

The British Cotton Growing Association's report on the unselected Cawnpore-American of the 1912 crop, which is reproduced here for convenience, stated as follows :—

"302 Cawnpore (American). Equal to about low middling in grade, rather dull, staple $1\frac{1}{8}''$, silky, strong but irregular."

Not only are the races Ca 7, 9 and 18 superior to the original in grade, which might be due to better handling and ginning, but the staple has been maintained and the irregularity complained of removed.

It may be explained that the other races, though known to be somewhat inferior to the others in staple, were all retained for

special reasons until further field trials had been made. No. 11 is an exceedingly early flowering type, Ca 5 is a very prolific yielder and has a high ginning percentage, whilst Ca 1 is of a larger habit than the others and has yielded exceptionally well in certain years.

The accurate comparison of a series of cottons for yield is necessarily a matter of some years, especially with seasons so variable as are experienced in Cawnpore. The monsoons of 1915-17 were entirely abnormal, rainfall being excessive and cotton yields over the greater part of the province unsatisfactory. Not only did this hamper work by reducing the amount of seed available for the succeeding years' work but the results themselves require confirmation in more favourable years. It can, however, be stated that Ca 7 and Ca 9 (and Ca 5, Ca 11) have given yields well above the average in unfavourable years. Ca 18 may possibly prove unsuitable for Cawnpore owing to its longer vegetative period and late maturing.

In ginning percentage Ca 7 (33 per cent.), Ca 9 (33 per cent.), Ca 5 (34-35 per cent.), and Ca 11 (33 per cent.) are superior to the original field crop (30-31 per cent.).

It has been proved that given an adequate irrigation supply for timely sowing and adequate marketing arrangements Cawnpore-American cotton can be profitably grown around Cawnpore. Among the above-mentioned pure races we have apparently cottons suited to Lancashire requirements. Incidentally, we have generally been able to obtain adequate prices for Cawnpore-American cotton from Cawnpore mills.—[B. C. BURT.]

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NOTE ON PROTECTING COTTON FLOWERS FROM NATURAL CROSSING.

NATURAL crossing takes place in all cottons to a greater or less extent, and its seriousness has been demonstrated and admitted in all countries. The Indian varieties cross freely with each other, and when these are grown together in breeding plots or in comparative trials, care is necessary to maintain them pure. For the same reasons all promising strains evolved from single plants must be protected. In fact the danger from natural crossing is so great that every seed allowed to ripen in the usual manner is of doubtful origin.

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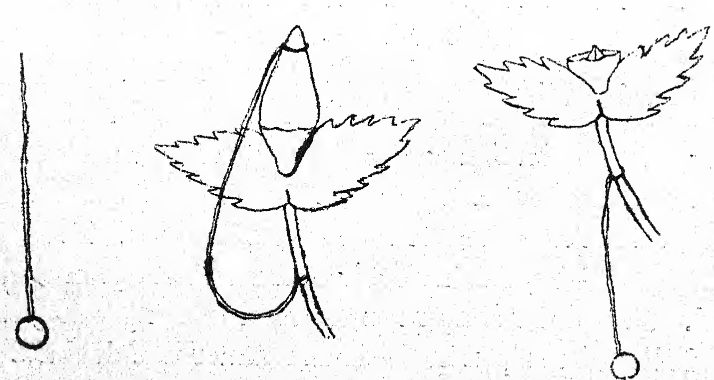
Natural crossing can be prevented by growing the cottons in bee-proof cages. It may not be, however, possible to provide such cages, and, moreover, they are unnecessary in many cases when only a small quantity of the pure seed is needed. Single plants can be protected by netting; but the netted plants attract the jackals and are damaged by them. They also suffer seriously from the attack of aphis. Under these circumstances, it has been found very convenient to protect a few flowers on every plant required pure for propagation.

The usual method of protecting the flowers is to cover them by means of small paper bags. Bagging presents certain difficulties. The paper used should be strong enough to bear the beating of the surrounding branches, especially when the wind is blowing hard. The tying also should be done carefully, otherwise the bag goes off the flower. The expense and trouble in making the bags and putting them on to the flowers is also considerable. Taking these things into consideration, another method was tried by the writer last year and was found to be very effective. Rings made of thin wire were employed in place of paper bags. These were put on the fully developed buds before they commenced opening. The form of the flower being a cone, there was no difficulty in putting the rings tight, and these prevented altogether the opening of the petals. Further the stalk of the protected flower was marked by a piece of cotton thread attached to the ring. The following figures illustrate the method :—



The method is easy, simple and inexpensive. It therefore claims general application on all farms where the necessity of maintaining the varieties pure is felt.—[G. L. KOTTUR.]

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IN the Kohat District of the North-West Frontier Province, there grows wild the **dwarf-palm** *(Nannorhops Ritchieans)* known locally as *mazri*. In one tahsil alone the area occupied is estimated at about 100 square miles, and the total annual production of leaves at about 500,000 maunds or about 8 maunds per acre. Like the coconut palm of the West Coast, *mazri* plays an important part in the economic life of the people of the district, for no portion of it goes without use. Its leaves produce an excellent fibre for preparation of sandals, cordage ropes, floor and roof matting, baskets for household use, punkhas, skullcaps, brooms, etc.; its dry leaves are used for lighting fires and its fruit is eaten. There is also a considerable demand for *mazri* articles in other parts of the Frontier Province and in the Punjab, and in addition to the local production valued at about five lakhs of rupees, *mazri* articles of the aggregate value of Rs. 1,22,203 were imported during 1915-16 from the Kurram Valley, Tirah, and Kabul. As stated above, *mazri* in the Kohat District grows wild and is not cultivated, and the manufacture of fibre articles is carried on in a more or less haphazard manner. In view of the considerable industrial possibilities of the palm, Babu Ram Sarup Dutt, of Kohat, submitted a paper to the Indian Industrial Commission, giving a history of the present condition of the trade in *mazri* and embodying suggestions for its commercial exploitation on a wider basis. He has supplied us with a copy of his paper, and we notice that he suggests the utilization of *mazri* leaves as a substitute for other costly fibres, for manufacture of paper, pasteboard and brushware, and for articles of household use such as chairs, suit cases, hat boxes, meat safes, tiffin baskets, door mats, etc. His suggestions are based on the fact that similar

varieties of dwarf-palm are put to these uses in other countries, but he acknowledges that much investigation is necessary. Considering the backward condition of the province, Babu Ram Sarup suggests that Government should pioneer the industry, and if the experimental factory is found a commercial success, it may be made over to a private body under proper Government control. He believes that there would be no dearth of labour, for the discharged sepoys of the Kohat District will be available in numbers. What interests us specially is the writer's suggestion that experiments may be made as to whether *mazri* can be cultivated as a field crop and that attempts may be made to extend its area. This will naturally follow if the claims made on the industrial side are justified by results, for as Babu Ram Sarup himself says, "once the zemindar comes to realize that the plant is coming to be counted as a plant of great commercial value, he will leave nothing undone to promote its growth." If it is to remain a cottage industry, the sovereign remedy for all its ills lies in Co-operation, to which the energies of the public-spirited people of the district might be usefully directed.—[EDITOR.]

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BY-PRODUCTS OF SUGAR MILLS IN FORMOSA.

SUGAR factories in Formosa generally work for six months in the year, from the middle or end of November to May, though in years of good crop work may extend for seven or eight months, from early in November to the end of May or June. For the rest of the year no work is done other than repairs.

According to information supplied by H. M. Commercial Attaché at Yokohama, the molasses produced is manufactured into alcohol and "Tomitsushu," the latter appearing to be a liquor somewhat similar to rum, and which is used by Formosans. There seems to be but little molasses wasted, though a considerable quantity has been exported to China and Japan or sold locally.

The following table gives the quantity of molasses, alcohol and "rum" (Tomitsushu) in recent years :—

Year	Output of molasses	Quantity used for alcohol	Quantity used for "rum"	Total
	* Kin	Kin	Kin	Kin
1912-13	59,325,018	20,573,360	32,810,810	53,384,170
1913-14	42,951,244	12,619,247	19,418,488	32,037,735
1914-15	37,234,126	22,631,125	17,852,451	40,483,576
1915-16	77,612,097	63,328,048	17,981,514	81,309,598
1916-17	140,478,843	99,461,425	21,546,532	121,007,957

* Kin=1·323 lb. av.

The above figures are supplied by the Bureau of Productive Industries, but it is evident from the totals that considerable quantities of molasses must at times be carried forward to the next year.

There are no special Government regulations controlling or restricting the fermentation of molasses, other than the general law governing the manufacture of saké. The alcohol and "rum" produced are liable to taxation.

No molasses is thrown away. Occasionally when there is a shortage of fuel, molasses may be poured over crushed cane, which is then used as fuel.

At times molasses has been used for cattle food. So far, however, there has been no excess really available as a regular cattle food.

A certain quantity of molasses is exported to Japan and China, to the former by the sugar mills, and to the latter by Formosans.

The quantity of such export in recent years has been as follows :—

Year	Export to Japan	Export to China, etc.	Total
	Kin	Kin	Kin
1912-13	4,443,153	843,931	5,287,084
1913-14	2,559,776	247,687	2,807,463
1914-15	433,360	1,053,429	1,486,789
1915-16	65,290	6,294,095	6,359,385
1916-17	1,650	11,796,668	11,798,318

The manufacture of alcohol and "rum" is not regarded as a by-production of the mills. The business is conducted separately though it is not stated whether separate amounts of capital are allotted to the molasses business. The percentage of production of molasses has been stated to be 27 kin to 100 kin of sugar, and the prices of molasses have fluctuated between 3·30 yen* per kin and 0·40 yen per kin with an average of 0·60 yen to 0·70 yen per kin.—[*The Board of Trade Journal*, dated July 11, 1918.]

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HOME SUPPLIES OF POTASH.

It seems quite probable that the United Kingdom, after the war if not earlier, will be in a position to supply itself with potash, and so become totally independent of German and other sources from which we drew to a very considerable extent in pre-war days. Of course we have no natural potash deposits such as those which exist at Stassfurt in Saxony, and are sufficient to supply the needs of the whole world, but potash is present in many things, and not least in blast furnace dust. As the result of experiments in North Lincolnshire it has been found possible by the addition of a small quantity of common salt to the furnace burden to extract potash in considerable bulk at practically little more than the cost of the salt. With the financial support of the Government a factory has been built and equipped at Oldbury, near Birmingham, capable of an output of 400 to 500 tons of potassium chloride per week, and it is part of the scheme, according to the *Board of Trade Journal*, to erect also a conversion factory, where the chloride not needed for agricultural purposes may be converted into refined potash salts. Other factories in the neighbourhood of blast furnaces in Cleveland and elsewhere are reported to be in contemplation. It is estimated that 50,000 tons per annum could be made available at an economical cost. Great Britain requires now about 30,000 tons of potash fertilizer, besides smaller quantities for the glass, soap, dye, match, and other industries annually. Before the war we imported potash compounds to the value of one and a third

* Yen = 2*s*. 0½*d*. at par.

million pounds (£1,380,567 in 1913), of which 66 per cent. was derived from Germany and the remainder from France, Russia, British India, Belgium, etc. The cessation of imports from Germany created a serious position for England, but the difficulty has been overcome by importing enormously increased quantities of nitrate of potash (saltpetre) from India, and various compounds from elsewhere. The need even for this is now disappearing to some extent, as a result of the development of home production. Germany placed great reliance upon her State-managed potash business, the sales of which in 1913 had a value of over ten millions sterling, and by reason of this had also a practical monopoly of optical glass manufacture.—[*The Economist*, dated September 21, 1918.]

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THE PRODUCTION AND VALUE OF ARTIFICIAL RUBBER.

It is reported from Germany that the well-known chemical and dye firm, Farbenfabriken vormals Friedrich Bayer and Co., in Laverkusen, has considerably extended its works for the purpose of manufacturing artificial rubber. The history of the German effort to produce this substitute dates before the war. The early attempts had perforce to be given up when the price of natural rubber fell from 30 to 4 marks per kg. After the outbreak of war, when the rubber shortage in Germany became acute, it was impossible to continue the pre-war output of artificial rubber, since the necessary plant had long since been scrapped and the requisite raw materials, acetone and aluminium, were not to be had. Before long, however, both these commodities began to be produced in increasing quantities. Coal and carbide yielded acetone, and the production of aluminium was undertaken on a large scale, with the financial assistance of the State, especially by the Griessheim-Elektron concern, which in conjunction with the Metallgesellschaft set up three buildings for the purpose. After these preliminaries the manufacture of artificial rubber could be resumed. Hard rubber was comparatively easy to produce, but the production of soft rubber presented much difficulty. The news that additional

artificial rubber factories have been opened, however, makes it appear probable that there has been progress in this field. The great question is, can artificial rubber compete with natural rubber? The answer varies with the use to which the substitute is put. Quite generally, however, according to *Vorwärts*, a doubt may be expressed as to whether synthetic rubber can stand the test, especially in view of the present selling prices, which are many times greater than the prevailing prices on the London rubber market.—[*The Board of Trade Journal*, dated September 26, 1918.]

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THE second annual **sale of surplus stock from the pedigree Montgomery and Ayrshire-Montgomery herds** was held **at Pusa** on Monday, the 9th December, 1918, when 34 head fetched Rs. 5,705 under the hammer, an average of Rs. 167 per head all through.

	Average price. Rs.
Montgomery bulls	203
Montgomery bull-calves	132
Montgomery heifers	140
Montgomery cows	164
Montgomery-Ayrshire bull-calves ..	234

The bidding was very keen and there was specially a keen demand for cross-bred bull-calves as the figures show. The next sale will probably be held in March 1919.—[WYNNE SAYER.]

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

Sir Edward Maclagan, K.C.S.I., K.C.I.E., I.C.S., some time Officiating Member in charge of the Revenue and Agriculture Department of the Government of India, has been appointed Lieutenant-Governor of the Punjab, *vice* Sir Michael O'Dwyer, G.C.I.E. We offer him our sincere congratulations.

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We offer our hearty congratulations to Major (Temporary Lieutenant-Colonel) F. S. H. Baldrey, F.R.C.V.S., formerly of the Indian Civil Veterinary Department, who has been admitted a Companion of the Most Distinguished Order of St. Michael and St. George for services rendered in connection with the war.

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Major (Honorary Lieutenant-Colonel) John Walter Leather, V.D., has been permitted, on resignation of his commission in the United Provinces Horse, to retain his honorary rank.

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His Majesty the King-Emperor has graciously granted to Mr. Ernest Shearer, formerly of the Indian Agricultural Service, and at present of the Egyptian Ministry of Agriculture, authority to wear the decoration of the Order of the Nile (Third Class) granted to him by the Sultan of Egypt in recognition of valuable services.

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His Excellency General Sir Charles Monro, in his despatch dated 20th August, 1918, on the work done in India during the first three years of the war, mentions the names of the following, among others, for particularly valuable services rendered by them :—

Lieutenant-Colonel G. H. Evans, C.I.E., A.D.C., Indian Defence Force ;

Lieutenant-Colonel H. T. Pease, C.I.E., V.D., Indian Defence Force ; and

Lieutenant-Colonel G. K. Walker, C.I.E., F.R.C.V.S., Indian Defence Force.

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CAPTAIN (TEMPORARY) G. C. SHERRARD has been mentioned by Lieutenant-General W. R. Marshall, Commanding-in-Chief, Mesopotamia Expeditionary Force, in his despatch dated 15th April, 1918, for distinguished and gallant services and devotion to duty.

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MR. A. HOWARD, C.I.E., Imperial Economic Botanist, and Mrs. G. L. C. Howard, M.A., Second Imperial Economic Botanist, were on privilege leave for six weeks from 21st October, 1918.

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DR. HAROLD H. MANN, Principal of the Agricultural College, Poona, has been appointed to act as Director of Agriculture, Bombay Presidency, *vice* the Hon'ble Mr. G. F. Keatinge, I.C.S., (on deputation), pending further orders.

Mr. J. B. Knight, M.Sc., Professor of Agriculture, Agricultural College, Poona, acts as Principal, *vice* Dr. Harold H. Mann, pending further orders.

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THE designation of Mr. H. M. Chibber, M.A., Second Economic Botanist, Bombay, has been changed to "Plant Breeding Expert to the Government of Bombay."

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MR. P. C. PATIL, L.Ag., Acting Deputy Director of Agriculture, Northern Division, Bombay, has been granted privilege leave for three months. Mr. B. M. Desai, Assistant Professor of Dairying, Agricultural College, Poona, has been appointed to act during Mr. Patil's absence.

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RAI BAHADUR K. RANGA ACHARIYAR, M.A., Lecturing and Systematic Botanist, Agricultural College, Coimbatore, and Mr. J.

Chelvaranga Razu, Acting Deputy Director of Agriculture, IV Circle, Madras, have been admitted into the Indian Agricultural Service with effect from 6th June, 1918, and 29th May, 1918, respectively.

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The services of Mr. Daulat Ram Sethi, M.A., B.Sc., Deputy Director of Agriculture, Orissa Circle, have been placed at the disposal of the Durbar of the Kapurthala State in the Punjab for three years.

Mr. S. K. Basu, M.A., Assistant Professor of Mycology, Sabour College, has been appointed to act as Deputy Director of Agriculture, Orissa Circle, during the absence, on deputation, of Mr. Sethi, or until further orders.

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Mr. W. Youngman, B.Sc., has been admitted to the Indian Agricultural Service and appointed Assistant Economic Botanist in the United Provinces.

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Mr. E. A. A. Joseph, B.A., I.C.S., Director of Agriculture, Punjab, has been appointed to officiate as Revenue Secretary to the Government, Punjab, and Mr. S. M. Jacob, I.C.S., officiates as Director in Mr. Joseph's absence.

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Mr. F. J. Warth, M.Sc., Agricultural Chemist, Burma, who was posted to duty with the Mandalay Battalion, Burma Military Police, has reverted to the Agricultural Department.

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Mr. C. P. Mayadas, M.A., B.Sc., Assistant Director of Agriculture, Western Circle, Central Provinces, has been transferred in the same capacity to the Northern Circle.

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The Government of India have approved of the recommendation made by the Board of Agriculture in India in December 1917 that sectional meetings of the Board should be held in years in

which there is no full meeting of the Board, and the following sectional meetings have been arranged for this year :—

Section	Place of meeting	Date
Entomological Section	Pusa	3rd February, 1918, and following days.
Mycological Section	Pusa	20th February, 1918, and following days.
Chemical Section	Pusa	24th February, 1918, and following days.
Veterinary Section	Lahore	24th March, 1918, and following days.

Reviews.

A **Survey and Census of the Cattle of Assam.**—By J. R. BLACKWOOD, LL.B., I.C.S., Director of Agriculture, Bengal. Calcutta: The Bengal Secretariat Book Depôt, 1916. Price Rs. 3-11 or 5*s*. 6*d*.

At the suggestion of the Government of India that a report on the survey and census of cattle in each province should be prepared on the lines somewhat similar to the Punjab report on the subject issued in 1910, the late Eastern Bengal and Assam Government selected Mr. Blackwood for this duty in November 1911. After the redistribution of the provinces he was instructed to prepare separate reports for Bengal and Assam. A review of the report for the former province has already appeared in the *Journal* (vol. XII, pt. IV). It is the report of the latter province that forms the subject of this review.

According to the census, the number of cattle in Assam is 4,840,348, of which, approximately, one-tenth are buffaloes. The proportion is roughly 7 head of cattle to every 10 inhabitants. This is considerably higher than the proportion in Bengal. Within the province itself the ratio in various districts differs greatly. In the Surma Valley which is comparatively thickly populated and where a great part of the land is submerged deeply for several months in the year so that cattle have to be stall-fed, 1,808,287 cattle have been enumerated, roughly, 1 to every 3 human beings. In the Assam Valley, where there are many unoccupied areas and unlimited grazing, over three millions of cattle of all sorts (3,032,061) have been found, a number not far short of the whole human population of the tract.

The breeds of cattle in Assam can be conveniently divided into three classes :—

(1) Wild cattle.

(2) Hill cattle.

(3) Cattle of the plains.

The wild buffalo is found throughout the swampy Terai of Assam. Among hill cattle, those* in Manipur are generally superior to the ordinary village cattle of the plains. In the Naga Hills people do not use their cattle for ploughing or carting; they never milk the cows but use cattle solely for food. In the Jaintia Hills a very good class of animal is found. The Garos also do not drink milk, nor do they breed cattle themselves. They generally buy bull-calves from the Nepali *bastis* in the district or in the plains, fatten them and then either kill or sell them.

The poor quality of the cattle in the plains is well known, and is largely due to climatic conditions combined to a great extent with the usual ignorance and apathy peculiar to indigenous cattle breeding, coupled with neglect, starvation, inbreeding and the usual anti-castration attitude.

In many parts during the rains the cattle stand continuously in mud and water and are fed on paddy straw. This state of affairs does not suit cattle, though it is all right for buffaloes. As a matter of fact the poor quality of the Assam cattle is in marked contrast to the fine quality of the Assam buffalo. The average milk yield of an Assam cow is less than that of a Bengal cow, being under a seer per day. The best of the local bullocks are considered by the cultivators good enough for the plough, but for heavy cart work fairly big strong animals are required and they are usually imported from Bihar districts. Improvement in the milking capacity of the cow, and better draught power in the case of bullocks are therefore required. It is possible to bring this about by crossing with suitable breeds.

In 1902 an experiment was started on the Upper Shillong farm of crossing Khasi and Bhutia cows with a bull of the Taylor (Patna)

* Particularly the bullocks, which are good draught animals.

breed. The female offspring of the cross showed much better milk results. Whereas a pure Khasi cow, it is said, will give only two seers of milk per day, the cross-bred animal gives as much as seven or eight seers per day. A pure Bhutia cow is reported to give only four seers of milk per day, while the cross-bred gives six seers.

Pure bred Patna bulls are given out by the Department in the mofussil, but the chief difficulty is to get the people to feed the bulls properly after they are sent out.

The Government of Bengal have established a cattle-breeding farm at Rangpur (which is on the borders of Assam) where experiments have been undertaken to determine whether the improvement of the local breeds is to be by rigid selection of indigenous cattle or crossing with exotic breeds, such as Montgomery, and as the problems in Assam are somewhat analogous to those in Bengal, a recent Resolution of the Local Administration states that it is proposed to wait and see the issue of the experiment there before going in for any scheme of large cattle-breeding farms. In the meantime animals from the Rangpur farm will be obtained by the Department for employment as sires in the province.

The practice of growing fodder crops for cattle is practically non-existent at present in Assam. This is mainly due to the fact that, with the exception of a few thickly populated districts where all the land not taken up for rice is flooded, Assam is better off for grazing than many other provinces. In the more densely populated portions of the province, however, the provision of grazing for cattle already presents a serious problem, and the difficulty is growing year by year. Accordingly steps have been taken by the Local Administration to set apart lands for grazing and protect them from encroachment. These grazing reserves are of four main classes :—

(1) Village grazing grounds in which agriculturists' cattle graze free of charge ;

(2) grazing grounds in more remote localities, where professional graziers may keep large herds, paying the prescribed fees ;

(3) grazing grounds in the vicinity of small towns, where cattle kept for the supply of milk to the towns pay a reduced scale of fees; and

(4) village forests in which grazing may be allowed in accordance with the rules for the management of the forest.

The quality of the cattle found in any tract does not depend merely on the abundance or otherwise of grazing, but on climate and several other equally important factors, and it is clear that ultimately the ryot in Assam will have to take to growing fodder crops. Most parts of Assam are too wet for *jowar* (*A. Sorghum*), and until a suitable substitute is found or means devised of storing grass in the form of hay or ensilage, the cattle will have to depend very largely on pasture. In the opinion of the local authorities sufficient areas, therefore, must, wherever possible, be kept as grazing grounds. Up to now over 130,000 acres have been reserved for the purpose in the Assam Valley, and over 20,000 acres in the Surma Valley. This will not go far towards the support of some four million head of cattle, but in the more populated parts where such grounds are needed, it is already difficult to get suitable land.

With the growing demand for milk and other dairy products and the consequent rise in their prices, the benefits of selective breeding and proper feeding of cattle, the necessity of introducing suitable fodder crops, and of devising means for preserving grass and other fodder, should be impressed on the people. It is hoped that the Agricultural, Veterinary, and Co-operative Departments, working together, will be able to effect a marked improvement on the present state of things.

***

Bulletin of the Imperial Institute, London, January-March 1918.—This issue contains a very important article of 40 pages on "The Material Resources of Burma" by Sir Harvey Adamson, K.C.S.I., lately Lieutenant-Governor of Burma. With a fertile soil, a rainfall that has never been known to fail, abundant fisheries, magnificent forests, and rich but hitherto almost unexplored mineral wealth, Burma might be expected to offer a promising field for commercial enterprise. Yet, with the exception of rice, teak, and

mineral oil, its products have not to a great extent attracted British capital. The chief reasons for this failure are dearness of labour and deficiency in means of transport. With an area three times as large as Bengal, Burma has only about a fourth of the population of that province; consequently the wages of labour are twice as high as in India itself. The population of Burma is rapidly expanding both by natural increase and immigration. It would expand still faster, says Sir Harvey Adamson, if the second great deterrent to the influx of capital were removed, and Burma were equipped with adequate railways and roads. To serve an area nearly twice the size of the United Kingdom, Burma has only 1,598 miles of railway. The length of metalled roads in the whole province is put down on paper as 2,100 miles; but most of these roads are not worthy of the name. Outside towns and their environs there are few roads that are fit for other than bullock-cart traffic, and very few miles where motor traffic is possible. The provincial contract given to Burma in 1907 was quite inadequate for the equipment of the province with necessary public works, and though the contract has since been augmented by the sum of 15 lakhs of rupees (£100,000) a year, Sir Harvey Adamson considers it still insufficient to meet the requirements of the province within a reasonable time. He gives particulars of the crops, agricultural stock, fisheries, forest products and minerals, all leading to the conclusion that Burma is a land of rich resources and great potentialities. There can be no doubt that capital judiciously expended, whether by Government in improving communications and developing natural resources, or by private enterprise in exploitation, would be profitably employed. A handsome return has been obtained from the capital already expended on revenue-producing public works. Sir Harvey Adamson asserts that there is no truth in the opinion often expressed that Government is adverse to private enterprise. In the interest of the tax-payer Government is bound to reserve for itself a fair share of the profits earned from the exploitation of the products of the country. Within this limit it welcomes and is ready to give priority to private enterprise. Unfortunately applicants for concessions have too often been adventurers who desire to take much and give

nothing in return, and who possess neither expert knowledge nor sufficient capital to utilize the products which they wish to exploit. Such applications, Sir Harvey Adamson points out, must be rejected; but where *bona fide* applications for concessions are made by experts or capitalists, the Government of Burma is always ready to welcome them, and never turns them down without reasonable cause.

Among other articles in the Bulletin is one on natural dye-stuffs. The scarcity of synthetic dyes since the interruption of commercial relations with Germany has led to a search for new natural dye-stuffs and for new sources of supply of the better-known materials. Many samples of such products have been received at the Imperial Institute, and the results of their examination are given in the Bulletin. The chief developments during the war have been, however, in the increased production of natural indigo in India and Java, and fustic in the West Indies. These two dyes are much in demand for the blue and khaki cloths required for naval and military uniforms. With regard to the future of natural indigo, it is pointed out in the Bulletin that the present demand will no doubt continue during the war; but the manufacture of synthetic indigo has been started in the United Kingdom, the United States, France, Switzerland and other countries, and after the war the natural product may have to contend with even severer competition than in the past.

Correspondence.

IMPROVEMENTS IN THE QUALITY OF UNITED STATES COTTON.

To the Editor,

The Agricultural Journal of India.

Sir,

I have just received the April issue (vol. XIII, pt. II) of the Journal. I was recently talking with Mr. Erwin W. Thompson, of the United States Commercial Department, best known for his most excellent reports on vegetable oils and oilseeds. He gave me to understand that, speaking generally, improvements in the quality of United States cotton had hitherto practically always centred round some particular large estate, the owner of which was able to grow a large quantity of his particular selection and was also in such a financial position as to be able to sell his produce on a wider market than the local one usually provided. Among the smaller growers who sell locally, similar results had not generally been obtained and there had been a slight deterioration in such crops. A perusal of Mr. Roberts' article in the Journal referred to seems to corroborate this opinion, but Mr. Roberts does not so far appear to state it categorically as a result of his tour of inspection. It would be of interest if he could or could not corroborate this opinion, for one point of great importance to India is a knowledge of any methods adopted elsewhere, whereby improvements in the quality

of cotton have been effected and *maintained* among a large number of small holders and growers.

Yours faithfully,

LONDON : D. T. CHADWICK,

5th July, 1918. *Indian Trade Commissioner.*

(*Enclosure.*)

DEAR MR. CHADWICK,

* * * * * *

Mr. Roberts says (page 278) : "The chief reason for Mr. Coker's success is that he is a buyer of fine cotton and is able to give proper value for good staple." I happen to know Mr. Coker and his work, and I think the "chief reason" is quite exactly stated. The certainty that a cotton grower will get pay for his cotton in proportion to its excellence is undoubtedly of more importance in the ultimate improvement of American cotton than any other one factor, not excepting scientific breeding. I say "not excepting" because as a matter of fact in the above circumstances scientific breeding would not permit itself to be excluded ; it would naturally follow. Conversely, scientific breeding cannot succeed commercially unless the grower can see some financial advantage ; he takes no interest in the means, he wants to see the end.

The American producer usually sells his cotton in small villages to cotton buyers who are paid salaries or commissions by dealers in large cities. Often there is a community of interests among these small buyers or at least a tacit understanding for buying the planters' cotton at the lowest possible prices. If one small grower brings to market a few bales of a most superior cotton he cannot obtain more for it than his neighbour who has an inferior grade, for the village price is usually based on an average for the district. As a natural consequence the small grower cannot afford to give the time and attention to quality, he works for quantity.

A large cotton plantation, say 50,000 to 60,000 acres, could afford to employ competent men to work for both quality and quantity. Proper machinery could be provided for cleaning and

selecting good sound planting seed. Prevention of outside hybridization would be more easy because of the large area under control. The cotton seed produced could be worked in an oil mill belonging to the plantation. And, finally, the amount of cotton produced would be large enough to justify selling on its merits in the large markets where there is world competition. The greater prices thus obtained would give a commercial impetus to cotton betterment, not on the plantation itself, but by force of example, in the country at large.

*   *   *   *   *   *

Yours sincerely,

LONDON.

ERWIN W. THOMPSON,

American Commercial Attaché,

Copenhagen.

MR. ROBERTS' REPLY.

TO THE EDITOR,

The Agricultural Journal of India.

SIR,

With reference to Mr. Chadwick's letter of 5th July, a copy of which you have kindly sent me, I beg to note that I can confirm Mr. Thompson's opinion quoted by the Indian Trade Commissioner. The most marked example of wide improvement I came across, was in the County of Hartsville, S. Carolina. The improvement there was brought about by the work of the Pedigree Seed Company run by Mr. Coker, who is an influential man there. He has been supplying improved strains now for over 12 years and has changed the character of the cotton of the whole county, of which 95 per cent. now produces cotton of $1\frac{1}{4}''$ to $1\frac{3}{8}''$ staple as compared to barely $1''$ previously. Mr. Coker has been able to do this as he has been a buyer also, with an interest in production of a superior staple. In the ordinary local markets a superior staple rarely gets a premium and hence progress has been spasmodic.

The two essential conditions for success with small holders are—

(1) supply of seed from one source, which is continually improving; and

(2) organization of marketing to secure full value for the improved cottons from the start or as early as possible after its introduction.

The Punjab policy is based on this. In Egypt, they are now supplying seed on a wholesale scale as in the Punjab and markets are fairly well organized, but seed given out is best seed from estates and factories and not of any pedigree or definite stock.

With cotton where seed has to be purchased from outside in any case, there is no difficulty in maintaining the standard. The cost of seed per acre being so small, helps to make this easier.

Yours faithfully,

W. ROBERTS,

Professor of Agriculture.

LYALLPUR:

5th October, 1918.

NEW BOOKS

ON AGRICULTURE AND ALLIED SUBJECTS.

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1. Treatise on Applied Analytical Chemistry, by Prof. V. Villavecchia and others. Translated by T. H. Hope. In two volumes. (London: J. & A. Churchill.) Price 21*s*. and 25*s*. net.

2. The Practice of Soft Cheese-Making: A Guide to the Manufacture of Soft Cheese and the Preparation of Cream for Market. Fourth Revision, by C. W. Walker-Tisdale and T. R. Robinson. Pp. 106. (London: J. North.) Price 3*s*. net.

3. A Short Handbook of Oil Analysis, by Dr. A. H. Gill. Revised, Eighth Edition. Pp. 209. (Philadelphia and London: J. P. Lippincott Co.) Price 10*s*. 6*d*. net.

4. Plant Genetics, by J. M. and M. C. Coulter. Pp. ix + 214. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press.) Price 1-50 dollars net.

5. Western Live-Stock Management, edited by Ermine L. Potter and others. Pp. xiv + 462. (London: Macmillan & Co.) Price 10*s*. net.

6. Lecithin and Allied Substances: The Lipius, by Dr. H. McLean. ("Monographs on Bio-Chemistry.") Pp. vii + 206. (London: Longmans, Green & Co.) Price 7*s*. 6*d*. net.

7. Common British Beetles and Spiders and How to Identify Them, by S. N. Sedgwick. Pp. 62. (London: C. H. Kelly.)

8. The Main Currents of Zoology, by Prof. W. A. Locy. Pp. vii + 216. (New York: H. Holt & Co.)

9. Production and Treatment of Vegetable Oils, by T. W. Chalmers. (London : Messrs. Constable & Co.) Price 21*s*. net.

10. Practical Surveying and Field Work, by V. G. Salmon. Pp. xiii + 204. (London : C. Griffin & Co., Ltd.) Price 7*s*. 6*d*. net.

11. Food Gardening for Beginners and Experts, by H. V. Davis, Second Edition. Pp. viii + 133. (London : G. Bell & Sons, Ltd.) Price 1*s*. net.

12. Rats and Mice as Enemies of Mankind, by M. A. C. Hinton. Pp. x + 63. (London : Trustees of the British Museum.) Price 1*s*.

13. Sir William Ramsay, K.C.B., F.R.S., Memorials of his Life and Work, by Sir W. A. Tilden. Pp. xvi + 311. (London : Macmillan & Co., Ltd.) Price 10*s*. net.

14. Medicinal Herbs and Poisonous Plants, by Prof. David Ellis. (London : Messrs. Blackie & Son.)

15. Canning and Bottling Fruit and Vegetables, by Mrs. Goodrich, with a Preface by Prof. F. W. Keeble. (London : Messrs. Longmans Green & Co.)

16. A Biochemic Basis for the Study of Problems of Taxonomy, Heredity, Evolution, &c., with especial reference to the Starches and Tissues of Parent-stocks and Hybrid-stocks, and to the Starches and the Hemoglobins of Varieties, Species, and Genera, by E. T. Reichert. (Carnegie Institution of Washington.)

THE following publications have been issued by the Imperial Department of Agriculture in India since our last issue :—

Memoir.

1. *Phytophthora Meadii* n. sp. on *Hevea brasiliensis*, by W. McRae, M.A., B.Sc., F.L.S. (Botanical Series, Vol. IX, No. 5.) Price R. 1-4 or 2*s*.

Bulletins.

1. The Improvement of the Indigenous Methods of Gur and Sugar Making in the United Provinces, by W. Hulme and R. P. Sanghi. (Bulletin No. 82.) Price As. 8 or 9*d*.

2. The Best Means of rapidly increasing the Outturns of Food Crops by Methods within the Power of the Agricultural Department. Being Notes submitted to the Meeting of the Board of Agriculture in India, Poona, 1917. Edited, with an Introduction, by J. Mackenna, C.I.E., I.C.S. (Bulletin No. 84.) Price As. 4 or 5*d*.

3. Moumachipalan, by C. C. Ghosh, B.A. (Bengali version of Bulletin No. 46 on "Bee-keeping.") Price As. 14 or 1*s*. 4*d*., net.

Indigo Publication.

1. The Future Prospects of the Natural Indigo Industry. The Effect of Superphosphate Manuring on the Yield and Quality of the Indigo Plant, by W. A. Davis, B.Sc., A.C.G.I. (Indigo Publication No. 4.) Price As. 4 or 5*d*.

Reports.

1. Scientific Reports of the Agricultural Research Institute, Pusa (including the Report of the Imperial Cotton Specialist), 1917-18. Price R. 1-4 or 2*s*.

2. Annual Report of the Imperial Bacteriological Laboratory, Muktesar, for the year ending the 31st March, 1918. Price As. 4 or 5*d*.

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3. Annual Report on the Progress of Agriculture in India.
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   (a) Botanical Series.
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WITH the commencement of the New Year the Journal will issue bi-monthly, namely, in January, March, May, July, September, and November, while the Special Indian Science Congress Number will cease to appear as a separate issue, papers read at the Congress being published in the ordinary numbers of the Journal. A series of coloured plates illustrating some common Indian birds of interest to agriculturists will be a new feature of the Journal.

The rate of annual subscription will continue to be Rs. 6, while the price of single copies will be reduced from Rs. 2 to R. 1-8.

G. A. D. STUART,

Offg. Agricultural Adviser to the

Government of India.

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(Vol. XIV, Part V.)

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Besides, there is one map accompanying Captain Sherrard's paper on "Vegetables during the Mesopotamian Campaign," and a cross section illustrating Mr. Inglis' "Note on Land Drainage in Irrigated Tracts of the Bombay Deccan."

The following Original Articles will appear in our next issue (January 1920).

Photo by George Craddock & Co.

COLONEL HENRY THOMAS PEASE, C.I.E., V.D., M.R.C.V.S.,
Principal of the Punjab Veterinary College, 1896-1907 and 1912-1919.

Original Articles

COLONEL H. T. PEASE, C.I.E., V.D.

Colonel H. T. Pease, C.I.E., V.D., Principal of the Punjab Veterinary College, retired on 20th July, 1919, after 34 years' service in India.

Henry Thomas Pease belongs to an old Yorkshire family, settled near Hull since the reign of Charles I. He is the son of F. R. Pease, Esqr., of Rusholme Hall, and was born in 1862. On leaving school, he took the diploma course at the Royal Veterinary College, London, and after some experience in a large practice in the north of England, he joined the Army and came to India in 1885.

In 1888 he was given an officiating staff appointment as Assistant Superintendent, Horse-breeding Department, and on the conclusion of that duty was posted as Veterinary Adviser to the Punjab Government and Professor in the Lahore Veterinary School. In 1891 he was specially selected as Superintendent of Bacteriological Survey, and posted to the Bacteriological Laboratory at Poona where he assisted Dr. Lingard in his researches into surra in horses. He soon realized that Poona was quite unsuitable for the requirements of a laboratory engaged in the study of contagious animal diseases. He was placed on special duty to select a more suitable site, and eventually chose Muktesar as possessing most of the necessary requirements. He received the thanks of the Government of India for work done in 1893, and was then appointed Assistant Inspector-General and placed in charge of the cattle and disease branch of the department, a post which enabled him to devote considerable time to the development of the laboratory and at the

same time to direct attention to cattle-breeding and the organization of the department for the treatment of disease in the districts. In the former direction he commenced to collect information regarding the good breeds of cattle, and prepared reports on the indigenous breeds in the Punjab, Mysore, Nellore, and Harriana, all of which were published in manual form. He also prepared a horse-breeding manual which was issued by authority, and for which he received the thanks of the Government of India. In regard to disease he endeavoured to stimulate research by the publication of up-to-date manuals on rinderpest, anthrax, hæmorrhagic septicæmia, black quarter, horse surra and ulcerative lymphangitis. He was also the compiler of the "Agricultural Ledger" on breeding, disease and cognate subjects.

In 1896 great difficulty was experienced in obtaining a Principal to succeed Col. Nunn at the Punjab Veterinary College and he volunteered to give up his appointment as Assistant Inspector-General to take up the work. But although Col. Pease left the Government of India, he remained their unofficial adviser in important matters connected with animal breeding and disease.

At the Punjab Veterinary College, he set himself to work to improve both teachers and students. He set about the preparation of text-books in Urdu himself and stimulated other teachers to do the same. He prepared books in Urdu on equine medicine, equine surgery, soundness and age, horse shoeing, handling of animals, veterinary jurisprudence and contagious diseases. In addition to this, he started and kept going for some years an Indian veterinary journal in Urdu. The present high reputation of the Punjab Veterinary College must be largely attributed to the excellent work of Colonel Pease. In 1905 he discovered the existence of a serious contagious disease among the horse-breeding stock, proved its contagious nature and demonstrated the cause. This was dourine, from which a great number of the stock were suffering, a disease which had doubtless for a considerable time made the results of the horse-breeding operations so bad. He also discovered the existence of hæmorrhagic septicæmia among cattle and buffaloes, and

was instrumental in bringing about the appointment of a Camel Specialist to deal with the diseases of that useful transport animal. In 1906, in collaboration with Baldrey and Montgomery, Colonel Pease started the "Journal of Tropical Veterinary Science," and from 1909, when the collaborators left India, carried on the work for four years practically single-handed. In 1906 he was awarded the title of C.I.E. for work done for the Government of India. In 1907 Colonel Pease was appointed to the post of Inspector-General of the Veterinary Department. He held the post until 1912, when the appointment was abolished, and then returned to the Punjab Veterinary College as Principal. On his return to Lahore the necessity for moving the college to another site had arisen, and he was called on to plan and equip the present new college, which he has made one of the best in the world.

The work which he has done is well known to scientists in all parts of the world and recognized by them. He was made a Foreign Correspondent of the Société de Médecine Vetérinaire in Paris and a Titulary Member of the Société des Sciences Vetérinaire. He is also a member of the Zoological Society of London. He was for many years a member of the Board of Scientific Advice.

In the midst of a busy life he has found time to devote to volunteering, and has for over 20 years been a member of the Punjab Light Horse, of which he was for years Adjutant and eventually Commanding Officer. The verdict of his comrades on his retirement was that his history was the history of the Corps. For his services in the Punjab Light Horse he was awarded the V. D. and appointed Honorary Aide-de-Camp to the Commander-in-Chief in India. For the services he rendered in connection with the Indian Defence Force in the war he was mentioned in despatches by His Excellency the Commander-in-Chief for valuable services rendered during the first three years of the war.

Colonel Pease is a distinguished Freemason at the head of the Craft, Chapter and Mark Degrees in the province.

The cheery humour and sound common sense displayed by Colonel Pease at successive meetings of the Board of Agriculture have endeared him to all officers of the present generation in the Veterinary and Agricultural Departments. The best wishes of all follow him into his well-earned retirement. [G. A. D. S.]

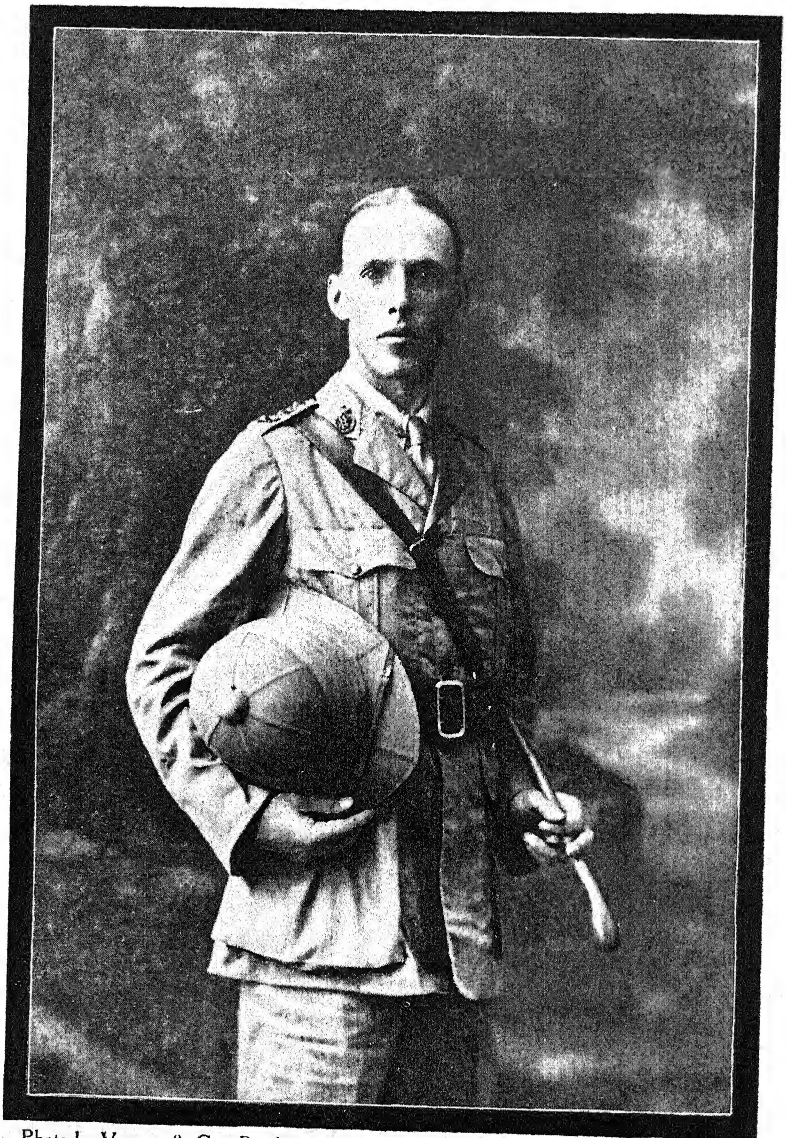


Photo by Vernon & Co., Bombay.

The late ARTHUR WILFRED SHILSTON, M.R.C.V.S.,
Second Bacteriologist, Imperial Bacteriological
Laboratory, Muktesar.

THE LATE ARTHUR WILFRED SHILSTON, M.R.C.V.S.

By the death of A. W. Shilston, from acute glanders, at the early age of 34, veterinary science in India has lost one of its most promising and valuable workers. In research and in routine work Shilston gave of his best. He had the true gift for research—foresight and rational imagination coupled with patience, perseverance and an infinite capacity for attention to detail. In routine he was prompt and resourceful. In both of these fields of work India is deeply indebted to him.

Shilston entered the Royal Veterinary College, London, in October 1904, and took his diploma in July 1908. His college career was brilliant and he was a marked man from the time he entered. Shortly after obtaining his diploma he was appointed to the Veterinary Research Laboratory at Pietermaritzburg, Natal, first as Assistant to Colonel Pitchford, and subsequently in charge. In March 1914, after a brief period of five weeks spent in England, he took up the appointment of Assistant Bacteriologist at the Muktesar Laboratories under Colonel Holmes. From February 1915 till October 1916, Shilston officiated as Imperial Bacteriologist, and afterwards held the appointment of Second Bacteriologist, up to his death.

In Africa Shilston did valuable work in connection with sheep scab, piroplasmosis, East Coast fever, and the production of anti-snake-venom serum. In India his energies were devoted to problems connected mainly with rinderpest, surra and dourine, and much valuable work in these subjects stands to his credit. Shilston first became ill on June 17th, and as he failed to make satisfactory progress he was sent on to Naini Tal on the 21st. The disease from which he was suffering steadily progressed and terminated fatally on July 6th. It can truly be said that his life was sacrificed to his work. [A. L. S.]

THE REPORT OF THE INDIAN COTTON COMMITTEE.

BY

FRANK NOYCE, I.C.S.,

Secretary to the Indian Cotton Committee.

THE issue of the Report of the Indian Cotton Committee is something of an event in the history of Indian agriculture. For the first time, the present position and future prospects of one of the great Indian staple crops has been exhaustively examined by a Committee of experts. An article on the Report in a Journal which is devoted to Indian agriculture is no more than its due, but the writer could wish that it had fallen to the lot of some one more competent than himself to contribute it. The Secretary of a Committee is, for obvious reasons, singularly ill-fitted to criticize its conclusions. All that can here be given is, therefore, some brief comments on the outstanding features of the Report so that any reader of this Journal who has not yet seen it may know what to expect.

The Report opens with an introductory chapter which gives an outline of the general position in regard to the world's supply of cotton which led to the appointment of the Committee. It also gives a brief description of the Committee's wanderings round India which extended from Lyallpur to Tuticorin and from Karachi to Calcutta. The Committee can claim that no important cotton tract was left out and that they visited many places in which no Imperial Committee had set foot before. In these pages, an expression of their grateful thanks for the hospitality which was showered on them everywhere, especially by officers of the

Agricultural Department, may perhaps be permitted. The Report proper is divided into two parts, the first of which deals with the agricultural and irrigational aspects of the problems which confronted the Committee and the second with their commercial aspect. The first part is again divided into chapters in which the cotton-growing provinces and Indian States are dealt with separately, and ends with some general recommendations regarding agricultural work on cotton. The second part contains four chapters only, a lengthy one on general commercial questions, more especially the question of preventing malpractices in ginning and pressing factories, one on cotton forecasts and statistics, one in which the establishment of an East Indian Cotton Association in Bombay, which will supersede the present Cotton Contracts Board, is recommended, and another in which the formation of a Central Cotton Committee to act as a link between the Agricultural Department and the trade is advocated

The summary of the views and recommendations in the Report occupies fourteen pages of the octavo edition, sufficient evidence of the detail into which the Committee have entered. Whatever view may be taken of their proposals, there can be no question that the Report is a mine of information on all matters relating to Indian cotton.

The problem which the Committee set out to solve may be briefly described as being to secure an improvement in the quality and outturn of Indian cotton and at the same time to secure for the cultivator a better price for his improved product and increased outturn. The ways in which this problem can be solved as revealed in the Report are by more research work, especially on the botanical side, improvements in agricultural practice, the provision of irrigation facilities, better organization, the prevention of malpractices which lower the reputation and *ipso facto* the price of cotton, and last, but by no means least, closer co-operation between the Agricultural Department and the trade.

Of all the methods by which an improvement in the quality and an increase in the outturn of Indian cotton can be secured, the most important is botanical work, and the first point which strikes

the reader of the Report is the success of the efforts which the Agricultural Department has already made in this direction. In the Punjab, the United Provinces, the Central Provinces, Madras, and the Broach, Kumpta Dharwar and Khandesh tracts of Bombay, it has already evolved strains of cotton superior to the local varieties in staple, yield or ginning percentage (that is, percentage of lint to the total output of lint and seed) and, often, in all three. The Central Provinces with their 700,000 acres under *roseum* offer the best example of what such work has done to improve yield and ginning percentage, the Punjab with its 276,000 acres under Punjab-American and the Tinnevelly tract in Madras with its 220,000 acres under *karunganni*, the best examples of what it has done to improve staple as well. The staple of *karunganni* is at least an eighth of an inch longer than that of the mixture known as Tinnevellys and its ginning percentage is some 5 per cent. higher. The staple of Punjab-American is about $\frac{1}{4}$ to $\frac{3}{8}$ths inch above the average of the indigenous cotton of the Punjab and, though its ginning percentage is much the same, its yield is much heavier so that the outturn of lint is much greater. In the other tracts in which the Agricultural Department has evolved superior strains, they have been literally in the field too short a time to "catch on" in the way that *karunganni* and Punjab-American have done. In the Broach and Kumpta Dharwar tracts of Bombay, they have made but little headway. One difficulty has been the lack of a suitable organization to push them. The breakdown of the Surat buying Syndicate which was formed by some of the Bombay mill-owners proved very detrimental to cotton improvement work in Bombay. Another obstacle to rapid progress is the fact that Broach and Kumpta cottons are varieties of *herbaceum* which, as pointed out in the Report, is possessed of very stable characteristics. It is, therefore, difficult to secure anything in the nature of a recognizable improvement in it. This also applies to the Westerns cotton of Madras. In that tract and in the adjacent Northerns tract, the Agricultural Department has put out two improved strains, Hagari No. 1 and Sircar No. 2, but their superiority over the local cotton has not been sufficiently marked to justify perseverance with them and it is, therefore,

proposed to make a fresh start with two other selections, No. 25 in the case of Westerns and No. 14, an especially fine strain, in the case of Northerns. 4 F does not represent the last word in American cotton for the Punjab and the Committee recommend further experiments with 280 F and 285 F, strains which it may be of interest to mention have proved exceedingly successful in Captain Thomas' experiments in Mesopotamia. The Committee, again, are not satisfied that *roseum* in the Central Provinces and Khandesh and Aligarh white-flowered cotton in the United Provinces represent the *ultima thule* of the Agricultural Department, and are anxious to see further efforts made to evolve a superior variety of *neglectum* or *indicum* or a cross between them which can compete successfully with *roseum* or Aligarh white-flowered cotton in the matter of profit to the cultivator whose interests, it may here be stated, have been the predominating consideration with the Committee throughout. It will be seen that there still remains a vast field for botanical work in tracts in which superior strains have already been evolved. There are also large tracts in which no botanical work has yet been done at all. Hyderabad, which produces over one-seventh of the cotton grown in India, is the most important of these. Others are the Coconada tract in Madras and the Dholleras tract in Bombay. Very little work has been done on the indigenous cottons of the Punjab, and the Committee regard botanical work on Cambodia as the most urgent of the problems affecting cotton in the Madras Presidency. Burma is also practically untouched. The ten botanists the Committee recommend should be added to the Agricultural Department for work on cotton will thus find ample employment. This addition will enable more attention to be paid to crossing, the possibilities of which have been revealed by Mr. Leake's important work at Cawnpore.

Improvements in agricultural practice tend more to an increase in the outturn of cotton than to an improvement in its quality. It is too much to expect that the 85 pounds of cleaned cotton which is all that India produces to the acre will ever be increased to 200 pounds per acre as in the United States but much of the leeway can doubtless be made up, if the detailed recommendations made by the

Committee after careful examination of the conditions in each province, are carried out. The most important improvements advocated are the spread of the practice of sowing in lines and of inter-culture and the working out of suitable rotations which should include, wherever possible, heavy yielding leguminous fodder crops.

Extensions of irrigation are of special importance in the case of cotton for, in addition to the increase of acreage and outturn they secure, they also mean an improvement in quality. The increase in acreage is an obvious result, for such extensions permit cotton to be grown where it was not grown before. The increase in outturn per acre is equally obvious, for irrigated cotton yields more heavily than unirrigated. The improvement in quality is not so obvious but it is secured by the substitution of the better varieties of cotton which require a longer growing season for the shorter stapled ones. Broadly speaking, extension of irrigation means the cultivation of more American cotton for, in the Peninsula in which the longer stapled indigenous varieties are grown, cotton is not an irrigated crop except in the case of Cambodia under wells in Madras. Of the three great cotton-growing provinces of the north of India, Sind holds out the greatest possibilities and up till now has the poorest performance. Fifteen years or so ago, 200,000 acres of Egyptian cotton were expected in the course of a few years. In 1917, practically no American cotton was grown except on the Government farms. The Committee have no hesitation as to the cause to which this disastrous failure to realize expectations is to be ascribed and the whole of the chapter on Sind is a powerful plea for the immediate construction of the Sukkur Barrage across the Indus which would "transform some four and a half million acres of culturable land, at present sparsely populated and indifferently cultivated, into one of the richest and most productive tracts in India." It would incidentally result, according to the Committee's very moderate estimate, in an area of 660,000 acres under cotton, of which about two-thirds should be cotton of longer staple than any at present grown in India, not excepting the best Cambodia, and at least $1\frac{1}{4}$ inches in length. If the yield were no more than 160 pounds of lint per acre which the Report states is the outturn

of irrigated lands in the Punjab, this would mean an addition to India's supplies of long staple cotton of 160,000 bales. In the Punjab, the Committee anticipate a total of 465,000 acres under American cotton under existing canals in the course of two or three years against a total area of 276,000 acres in 1917, and a further addition of 200,000 acres if three big irrigation projects under contemplation are carried out. Outside Sind and the Punjab the prospects of long stapled cotton under irrigation are much more nebulous. The area under American cotton in the United Provinces *might* increase from the few thousand acres at present to 135,000 acres under the Ganges and Agra Canals, provided a sufficiently high premium for it could be assured. The addition of the proviso shows that the Committee were not very hopeful about American cotton in the United Provinces and that there is uphill work in front of the Agricultural Department in those provinces if it is to succeed. There are some small possibilities for Punjab-American in the North-West Frontier Province, for Cambodia on the lateritic soils in the east of the Central Provinces and for Cambodia or Upland Georgian on lands which formerly grew poppy in Central India. The cultivation of Cambodia under wells should spread in Madras but it is impossible to make any estimate of the prospects as no survey of suitable lands has been carried out. The only recommendation in the Report in regard to indigenous varieties under irrigation is that liberal *takavi* advances should be granted for the construction of wells in North Gujarat where greatly increased yields have been obtained in the Kaira District in such conditions.

The "better organization" which was mentioned at the outset includes the organization both of the Agricultural Department and the cotton trade. To the recommendations the Committee make in regard to the organization of the trade reference will be made later. As for the organization of the Agricultural Department, it will be obvious that if the cultivator is to grow better varieties of cotton and to obtain the proper price for them, he needs all the advice and assistance the Agricultural Department can give him. If "the selection and distribution of pure seed are to be controlled by the

Agricultural Department in the manner best suited to the local conditions of each tract," a large increase in the number of seed farms is necessary. If the Agricultural Department is to demonstrate on the requisite scale the usefulness of improved agricultural implements and to convince the cultivator of the advantages resulting from the use of manures and from good cultivation, a large increase in staff is necessary. Such an increase is, above all, necessary, if the Department is to be in the best possible position to assist the cultivator in getting a better price for a superior product. The various ways in which this end can be secured are discussed in the Report. Warned by the fate of the Surat and Sind buying Syndicates, the Committee decide against buying agencies. The prospects of co-operative sale are hopeful but this is an agency the growth of which cannot be forced and something else is required. The Committee, therefore, advocate an extension of the system of auction sales of unginned cotton which has proved so successful in the Punjab, but consider that the Agricultural Department should not in any one case attempt to deal with more than 60,000 maunds of cotton which would give it control over 40,000 maunds of seed. After that, the sales should be handed over to other agencies, but the Department would still be called upon for advice and assistance in regard to such matters as grading, classification and the settlement of disputes. All this means a considerable expansion of what it is now the fashion to call "organization" and the additions to the staff of the Agricultural Department recommended by the Committee, apart from the ten Botanists mentioned above, an Entomologist for the United Provinces and an Imperial Mycologist, are one Director of Agriculture for Sind, thirteen Deputy and Assistant Directors of Agriculture belonging to the Indian Agricultural Service and three Assistant Directors belonging to the Provincial Service. For Indian States, the immediate additions proposed are two Directors of Agriculture and two Deputy Directors. The subordinate staff must, of course, be increased proportionately. The total annual cost of these proposals is estimated at Rs. 14 lakhs, which cannot be considered excessive in view of the importance of the cotton crop to India.

It is of little use for the Agricultural Department to spend its energies in inducing the cultivator to grow pure or superior varieties of cotton and to pick them clean, if he is prevented from securing the proper price for them by malpractices which he is powerless to check. The Committee give the cultivator a good character in this respect and state that the malpractices for which he and the village *bania* are responsible are of minor importance compared with those which are carried on in ginning and pressing factories. The recommendations in the longest and most important single chapter of the Report are directed to securing an improvement in the conditions which have made Indian cotton "a byword in certain markets almost throughout the history of the British connexion with India." The opening of central markets on the Berar system which enables the purchaser of cotton to see what he is buying and to pay for it accordingly, the publication of cotton prices in up-country markets in a way which will enable the cultivator to understand their true significance, and the standardization of weights on the basis of a cotton maund of 28 pounds, which will prevent his being cheated by the middleman, are all measures calculated to bring about the desired effect, but far more important than any of them is the system of licensing ginning and pressing factories which is recommended by the Committee. For the details of this scheme, the reader must be referred to the Report itself. Suffice it to say that, in future, the way of the offender will be very much harder than it has been in the past and that it should no longer be possible to fob off the man who produces a superior variety of cotton with the price of the inferior stuff with which it has hitherto been far too often the practice to mix it. Warned by the history of the Bombay Cotton Frauds Act, the Committee have worked out a scheme which involves the minimum of interference with honest factories. There will be no inquisitorial inspections by poorly paid subordinate officials which was the great grievance against the Bombay legislation. Complaints will be made by the sufferers and will be investigated by Committees on which the trade will probably have a preponderance of representation. If the trade is satisfied with bad cotton and prefers to pay for rubbish, there will, of course, be no

complaints and things will remain much as they are, but it is inconceivable that this should be so. Even if it is, one fruitful source of mischief will be removed for, under the Committee's proposals, the transport of cotton waste or of short staple cotton from one tract to another for the purpose of mixing with better varieties will be prohibited.

The chapter on cotton forecasts and statistics generally is worth study for many of the recommendations in it are applicable to other crops than cotton. Considerations of space prevent more than this brief reference to it.

We mentioned above that the Committee have suggested not only better organization of the Agricultural Department but also of the cotton trade. The way in which they propose that this should be brought about is by the establishment of a Central Cotton Trade Association in Bombay which, as far as control of the cotton trade is concerned, will take the place of the seven distinct bodies representing different branches of the cotton trade which existed at the time the Report was written and still exist, though the functions of two of the most important of them, the Bombay Cotton Trade Association and the Bombay Cotton Exchange, are at present exercised by the Cotton Contracts Board. The "East India Cotton Association" will be the permanent successor of the latter and there can be no doubt that its establishment will have a far-reaching effect in stabilising the price of cotton to the ultimate benefit of the cultivator.

In their last chapter, the Committee make provision for the much needed link between the Agricultural Department and the cotton trade. There can be no question that, valuable as the work which has already been accomplished by the Agricultural Department in improving Indian cotton, it would have been much more fruitful in results had there been closer co-operation between it and the cotton trade. Up till now, each of them has been amazingly ignorant of what the other has been doing. It would be an unprofitable task to apportion the blame for this. As the Irishman said when asked why an unpopular landlord had not been shot, what is everybody's business is nobody's business. There will, in

future, be no excuse for ignorance, for all interested in cotton, whether agriculturally or commercially, will be able to turn to the Central Cotton Committee for advice and assistance. It is proposed that this Committee should consist of about twenty members of whom nine will be officials. These will be the Agricultural Adviser to the Government of India who will be President, six agricultural experts working on cotton in the six great cotton-growing provinces, the Director General of Commercial Intelligence and the Director of Statistics. The remaining members, with the exception of a representative of the Co-operative Department who may be either an official or a non-official, will be representatives of Chambers of Commerce and similar bodies and will include a representative of Lancashire interests. Though the functions of the Committee are to be almost entirely advisory, its advice will be the best expert advice obtainable and will be of special importance in regard to the working of the system of licensing of gins and presses, as the penalty of withdrawal of the license of an offending factory will be inflicted on its recommendation. The Agricultural Department will no longer be in the dark as to what the trade really wants nor, as has been the case very frequently in the past, will it be confronted with conflicting reports as to the value of its improved strains. The services of the Technologist whom it is proposed to add to the staff of the Committee will be very valuable to it in the latter connexion. It should be mentioned that the Central Cotton Committee will work to a large extent through provincial and local sub-committees. If it becomes an accomplished fact, it should lead to an immense development of one of the most important raw materials which India produces.

MOTOR TRACTOR TRIALS AT PUSA.

BY

WYNNE SAYER, B.A.,

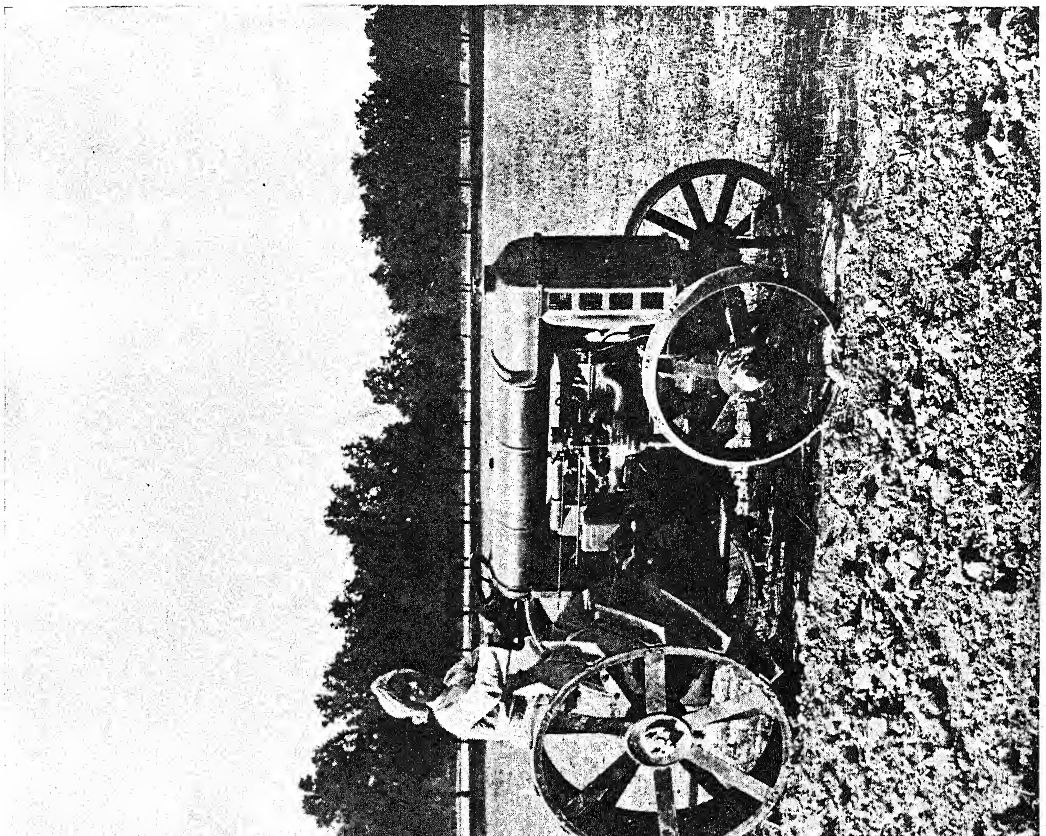
Offg. Imperial Agriculturist.

It being clearly evident from reports received from home that a type of motor tractor for agricultural work had been evolved which was capable of doing excellent work under ordinary farm conditions, arrangements were made to secure the first tractor imported into India of the type most likely to suit Bihar conditions in order that a trial might be undertaken on the farm at Pusa in the benefit of the agricultural public. The Fordson was chosen for four very obvious reasons :—

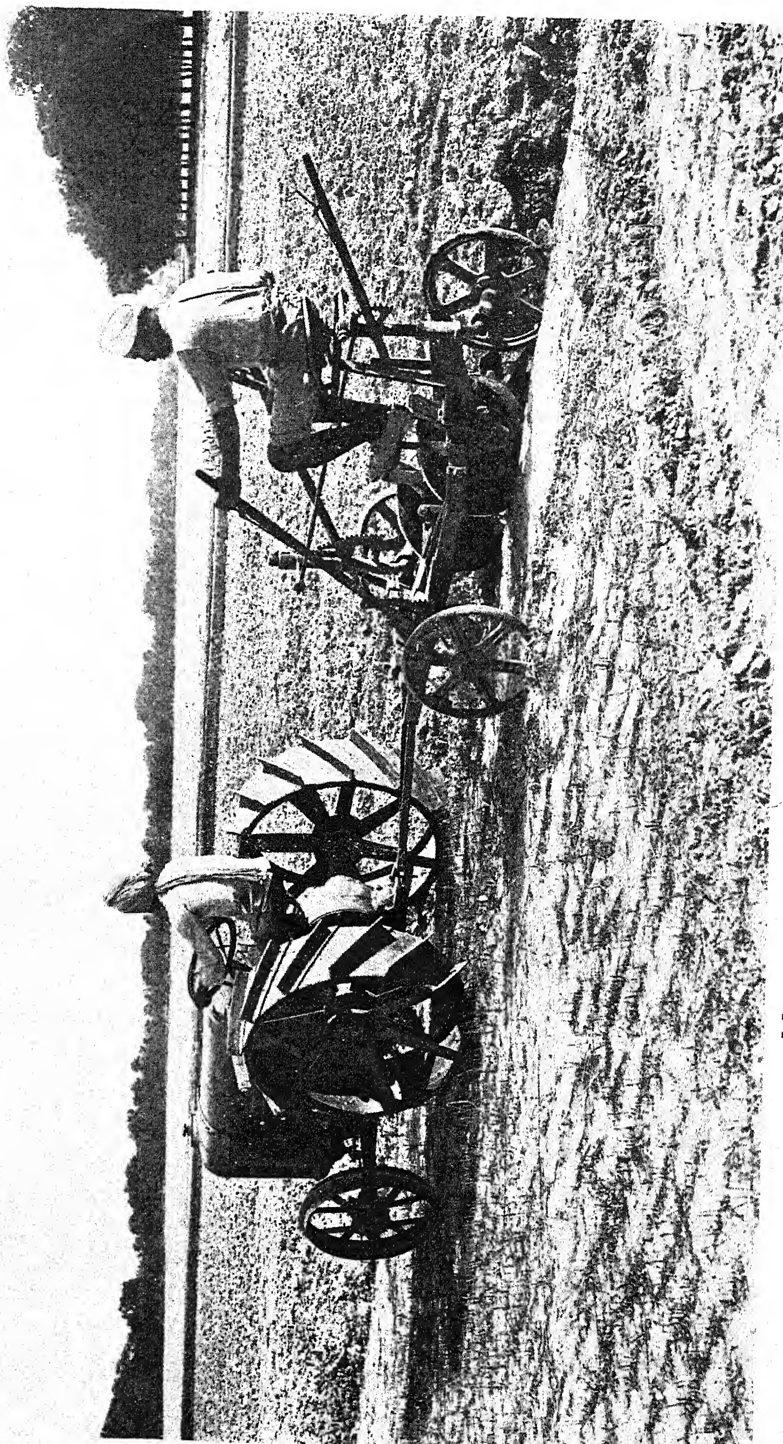
1. It was light and handy.
2. It was fully supplied with spares.
3. It was likely to be available very shortly, it was cheap, and if the demonstration was successful no difficulty would be experienced in procuring others.
4. It had done excellent work in all hands and under all conditions in England and was obviously a type of tractor which had been thoroughly tested.

It will perhaps be best to give a description of the Fordson here which, coupled with the photographs (Plates XXII–XXV), should make its details fairly clear to all.

The Fordson motor tractor is so constructed that the engine and all the working parts form the frame of the machine. A unit "Power Plant" is bolted to and forms a unit with the rear axle in the shape of a big T. In this T are stowed all the working parts.



Fordson Motor Tractor: view of engine from intake side.



Motor tractor working with double disc plough.

The T is mounted on four solid wheels. The wheel base is 63 inches and the tread is 38 inches. The tractor will turn in a 21-foot circle. The rear wheels are 42 inches in diameter with 12-inch rims. Overall length is 102 inches, height 55 inches and width 62 inches. The total weight of tractor is 2,700 lb. with water and fuel tanks filled, which hold 11 gallons and 21 gallons respectively.

The tractor can be used for a double purpose—both for hauling and ploughing. Its capacity as regards the latter is two 14-inch ploughs which are hauled at $2\frac{3}{4}$ miles per hour with the engine running at its normal speed of 1,000 r.p.m. The drawbar pull at ploughing speed is 1,800 pounds, which is increased to 2,500 pounds at low speed of $1\frac{1}{2}$ miles per hour. For road work and running light from place to place, there is a speed of $6\frac{3}{4}$ miles. The reverse is $2\frac{1}{2}$ miles an hour. For stationary work, a pulley is fitted on the side of the tractor and operated from the engine clutch. Twenty-two horse power is available at the pulley which runs at 1,000 r.p.m. The pulley is 9 inches in diameter and uses a six-inch belt.

The engine has four cylinders, each 4×5 inches. Petrol is used for starting, and when the vaporiser is sufficiently heated, kerosene can be substituted. The consumption of fuel varies naturally with the conditions, but is said to be not likely to exceed $2\frac{1}{2}$ gallons of kerosene per hour on the average. When the engine is at stationary work and running on full power, the consumption amounts to two and three-quarter gallons per hour.

The cost of the Fordson tractor is Rs. 4,250 f. o. r. Calcutta, and the Russa Engineering Works, Ltd., Calcutta, are the agents in India.

The tractor unfortunately arrived in India without any of the implements with which it was meant to be worked, but as it was all important to get some idea of its powers under Indian conditions (the quality of the work done being purely a question of the implements used), it was decided to use it with the implements available on the farm which, not having been designed for tractor haulage, made the test extra severe.

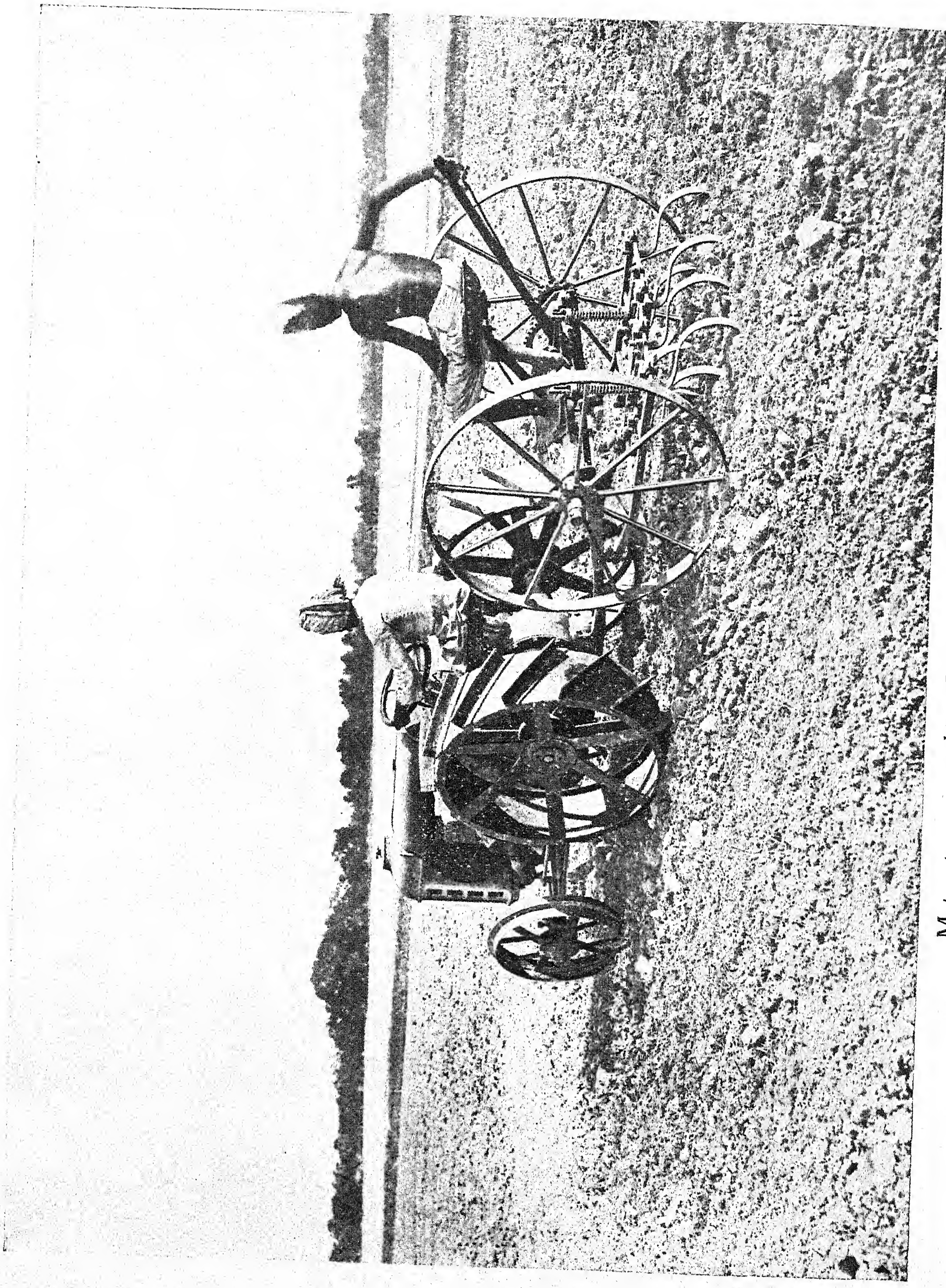
The tractor was worked on the farm for some days previous to the trial in order to familiarise the farm staff with it.

It was a welcome surprise to find from the start that at last an agricultural motor had been evolved which was obviously designed by some one who did really understand what was essential in dealing with agricultural conditions. Previous experiences in this line had shown us that whatever might be said in pamphlets, up to the introduction of the Fordson, no motor had been tried in India which would work under ordinary agricultural conditions; but here there was a total absence of the wild ideas about Indian conditions usually incorporated in agricultural machinery imported into India. The tractor proved easy to handle. The engine was exceptionally accessible in all parts (what this means, only people who have had to do running repairs to an American engine can tell). It was undoubtedly powerful, exceptionally handy and easy to drive; and as soon as the method of starting on petrol and the switching over on to kerosene had been explained, there was nothing else that the average *mistri* with a small knowledge of motor cars could not easily grasp; and once all those who drive a Fordson have found out by personal observation that if you let your clutch in too quick when in a bad place, the tractor rears up, you do not need to repeat the warning. This is the only risk other than those inseparable for the average moving vehicle and must be carefully guarded against and I would take this opportunity of warning all users of Fordsons in India about it. Some means of switching off the engine directly the tractor starts to come up, will have to be found, as a machine of this lightness and power will always wind itself up on its back axle under such circumstances. There is also a chance of burning out the vaporising tube if you allow the engine to run too long on petrol before switching over, and some means should be invented of cutting off the supply of petrol before this can happen in cases where, either from ignorance or accident, the engine is left running on petrol too long. A spare vaporiser tube should also be kept handy, and with the usual couple of spare plugs in reserve, no trouble should be experienced in running, provided the usual care is taken with oil and water supplies.

The land chosen for the trial was a piece of typical oat stubble which, owing to the continuous dry weather, had worked down pretty

Motor tractor working Cambridge roll and rake of spring tooth harrows.

PLATE XXV.



Motor tractor working Ransome's 8-tine cultivator.

hard. A piece of land, 400 yards × 20 yards, was marked out for the ploughing and another similar strip for the cultivator.

The tractor was first hitched to a double-furrow Ransome's disc plough which is pulled as a rule by three pairs of big bullocks. It worked this easily, the engine running with a good reserve on second speed and the way in which tractor and plough turned on the small head land was remarked by every one. Judging from the pace at which the work was done and the reserve which the tractor had in hand, it seems that it will be possible to do the class of ploughing required on such lands with a three, instead of a double, furrow plough.

A Ransome's 8-spring tined cultivator was then attached and another strip was grubbed at a depth of 5 inches. The way in which this work was done was especially notable for the ease with which the cultivator worked the land and the rate the tractor travelled at, and many present thought this method of dealing with stubble to be preferable under Bihar conditions to ploughing. The work done by such an implement, working 3 feet wide with 8 tines, approximates to that of the average iron plough used which while loosening does not invert the soil, while the breadth covered by the cultivator at each run is equal to 5 ploughs.

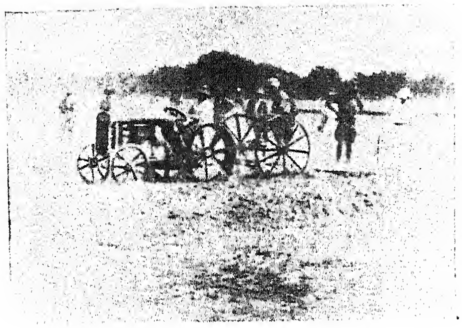
A rake of 3-spring toothed harrows was then run over the ploughed portion and much interest was displayed at the way the tractor travelled over a loose surface, showing no sign of poaching or failure to grip the soil.

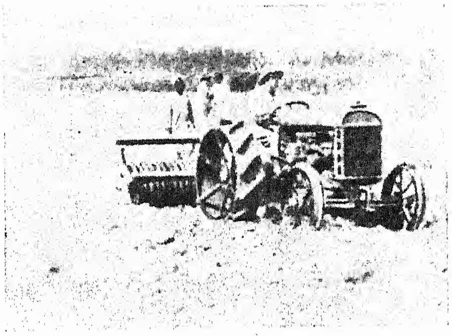
A Cambridge roll was then worked over the ploughed land and the remarkable efficiency coupled with the extreme lightness and handiness of the tractor, became evident. She travelled over the ploughed land easily and quickly, doing the work perfectly efficiently and finding no trouble from the depth and looseness of the soil, and the driving wheels, while breaking up the clods, did not pack the land at all. The tractor was very carefully watched with regard to this as it has been the chief thing to be feared with a mechanical prime mover working over the land.

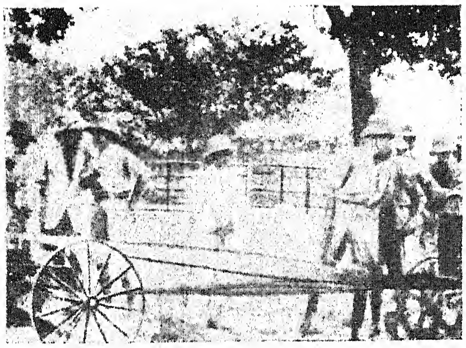
The tractor was then run off the land and driven on top speed up to the farm buildings where the driving pulley was fitted and the

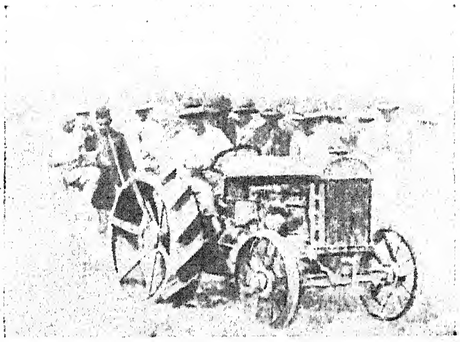
Climax silage cutter worked for half an hour. The engine took the load easily and ran regularly and steadily. Despite the extreme heat of the day, at no time did the water in the radiator approach boiling point, and the method by which the air taken into the carburetter is filtered through water, enabled the tractor to work in the heaviest dust without any choking. In short, the demonstration and trial, as far as proving the capabilities of the tractor went, were perfectly satisfactory. It now remains to test the tractor for fuel consumption, etc., and to watch its behaviour and work over a period in the hands of the average *mistri*. Tests to this end together with trials of the most suitable implements, especially for Bihar conditions, will be conducted, and I would take the opportunity of replying to all—and their number is legion—of the people who have spoken and written to me about this tractor as follows :—The tractor is under trial and I can express no opinion and give no figures yet but a report will issue in due course. A set of photographs taken by the cinematograph (Plate XXVI) illustrate this article showing the machine at work, and I shall be only too glad to show any one the machine working any day if they will write to me and fix a date.

I hope in the near future to have an engineer working in collaboration, as these experiments will require combination of engineering and agricultural knowledge to enable them to be thoroughly and satisfactorily carried out.









Motor tractor trial views from cinematograph film.

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VEGETABLES DURING THE MESOPOTAMIAN CAMPAIGN.

BY

CAPTAIN G. C. SHERRARD,

Deputy Controller (Agricultural Requirements, Mesopotamia), Indian Munitions Board.

U is the lake known as Um-el-Brahm
Which guards our left flank from all possible harm
And waters old Gomigee's barley farm
In the middle of Mesopotamia.

Mesopotamian Alphabet.

I BEGIN with the above quotation from that delightful doggerel the Mesopotamian Alphabet, because it is the first popular reference to agriculture made by the army in Mesopotamia. Unfortunately I can find no one who can tell me who Gomigee was, or where his farm.

I should like to talk about the Mesopotamian Alphabet, because I believe it contains, if read with sympathy, a real guide to the spirit of the old army, the army that fought its way under great difficulties to Ctesiphon, and nearly to Baghdad. The men who knew that things were going wrong, but, because soldiering was their "job," did not rave, or stop,—they joked. In the Alphabet the laugh at the ruling powers has something of an edge, but that at individual services is good-natured chaff, without a sting. The army that produced the Alphabet knew that the medical service was ill-equipped, that the transport was breaking down; but it also knew that the individual doctor was working night and day, that single transport officers were trying to do alone work that was later given to four or more, paying in mind and body for the strain. All this was changed. When I arrived the change had well begun; but I heard and saw enough to make me realize what went before.

Later, a new generation arrived, while conditions altered greatly; so the Mesopotamian Alphabet was very near forgot.

This, however, is not a paper on Mesopotamia, or the army, old or new, but only an account of the work of a branch of the Indian agricultural department, planted out behind that army in the field. It is unfortunate that the account contains so much of the letter I, but, as I have been asked to write a description of my work, and have not the necessary literary skill, I have had to do it the easiest way—and I ask for your indulgence.

I believe that Mr. Maxwell-Lefroy first suggested that a member of our department should go to Mesopotamia to grow vegetables and help to fight scurvy, when he returned from a tour in that country undertaken to advise on the destruction of flies. The proposal was seconded by Mr. Mackenna, and, I am glad to say, I was chosen for the work.

On August 13th 1916 I received a copy of a letter from the Government of India, which said, "it is proposed, with a view to obtaining supplies of fresh vegetables for the troops in Mesopotamia, that the Agricultural Department in India should assist in the introduction into that country of vegetable cultivation by lending to the Army Department the services of a Deputy Director of Agriculture with a staff of *malis*, and that Mr. Sherrard * * has been suggested as the most suitable * * if * * (he) is willing to undertake the duty * * (he) should be instructed to engage twelve *malis*." This raised many questions; but chiefly, two. What, exactly, was expected; and, why twelve *malis*? A visit to Simla did not elucidate matters to any great extent. There was an unformed idea that a vegetable farm should be started, but no explanation as to the reason for the precise number of twelve *malis*. The most definite statement was that of General Bingley, who said, "There are 175,000 men in Mesopotamia, and hardly any vegetables." Perhaps no one else put the facts so plainly for fear of scaring me out of my wits, even as it was I had a strong impulse to fly, and bury myself in the uttermost wilds of Bihar.

The next step was to collect the twelve *malis*. In those excellent market gardeners, the *koiris* round Bankipore, I thought I had

exactly the right material to my hand. But the *koiri* is timid, painstaking, and averse to leaving his native home (for which reason he is much sought after by landlords), and, though I had no difficulty in finding twelve good men, nothing would induce them to go to Mesopotamia, and they invariably bolted the day before they were to be entrained. It was very much like taking a sieve of oats to catch twelve shy colts loose in a large field. Obviously it was more important to find out what was happening to the 175,000 men with no vegetables, than to waste time endeavouring to overcome the coy reluctance of the *koiris* of Bihar. So I proceeded to Bombay.

There, and at Poona, through the good offices of the Director of Agriculture and the Economic Botanist, I was able to collect seven out of the twelve *malis*, and to make arrangements for vegetable seeds to be sent out to me from India as required. I then left for Basrah, where I arrived on September 16th 1916 and reported to Brigadier-General P. C. Scott, C.B., Director of Supplies and Transport, Mesopotamian Expeditionary Force. After some consultation, it was arranged that work in connection with the production of vegetables should become part of the S. & T. organization, and I was put under the orders of the D. S. & T.

It was now that I fully understood what was expected of the agricultural expert. Scurvy cases were being admitted to the hospitals at the rate of 3,000 a month, and evacuations and deaths were very numerous. There was a definite hope, therefore, that sufficient vegetables would be produced, to provide everyone with the regulation daily ration of 12 oz. of fresh vegetables for British and 6 oz. for Indian troops, and to stamp out the disease. However, though this was the object to aim at, the authorities were quite willing to admit that it was difficult to obtain, and that the full ration could only be raised with time, if at all. Their attitude, and particularly that of General Scott (with whom I dealt direct), was extremely helpful, and created a pleasant atmosphere to work in. It was as if they said: "You understand that the position is serious. As an agriculturist you will know best how to produce the vegetables. We will not interfere, or hamper you, and will give you what you

ask for (as far as this is possible among the conflicting demands of many important works); and then we hope for results." This is the army way, and it is a pity that it is not more common in civil life.

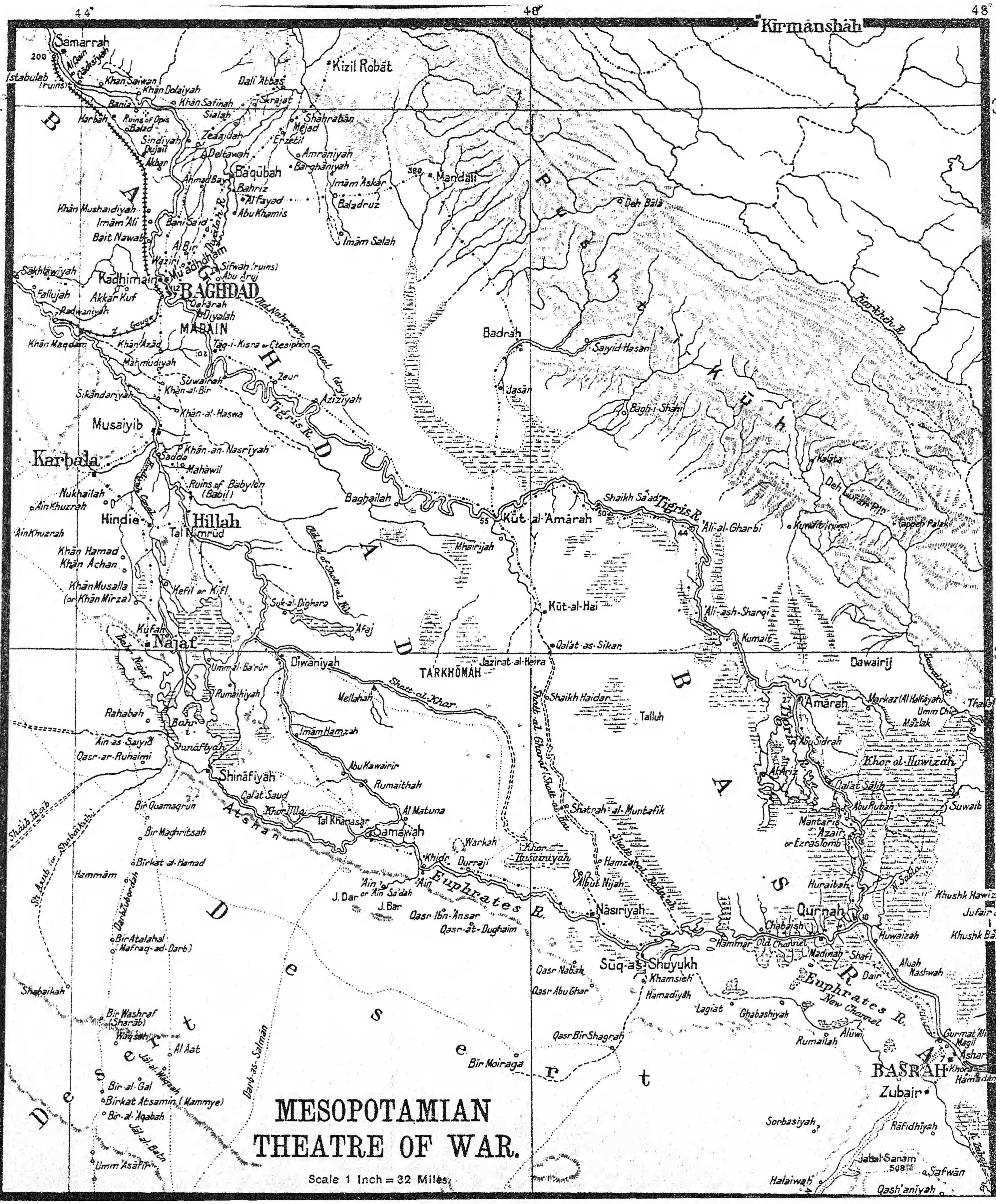
Later on arose the question of my official title. "What shall we call you?" "Anything that you think will do." "What were you called before, in your own service?" "A deputy-director of agriculture." "Well, that is quite a good name, go on calling yourself that, unless someone objects in the future." And so it became, temporarily, an official title in the S. & T. Corps. It was interesting—and, perhaps, amusing—to be the first deputy-director of agriculture ever attached to a British force in the field. The following pages attempt to show the doings of this small agricultural department up to the end of 1917, when it passed over to civil administration, and its story more properly belongs to the early history of the Mesopotamian agricultural department.

I. Before the advance.

You all know the position in Mesopotamia in September 1916, and here (as elsewhere in this report) it is only recalled sufficiently to explain what follows.

The army was holding the lines at Sannayat and Sinn, on both banks of the Tigris, and its supplies were sent up the river $243\frac{1}{2}$ miles, by steamer and barge, from Basrah to the advanced base at Shaikh Saad. From there they went, either by a light railway up the right bank, or by smaller boats to Arab Village, 22 miles further up the river.

The facilities for unloading the steamers and loading the river barges at Basrah were improving with almost marvellous rapidity, and continued to improve. But the railway from Qurnah to Amarah had not yet been built, and the whole line depended upon the river craft, a miscellaneous collection of paddle-boats and tugs, that had been recruited from all corners of the Empire. East Indian Railway boats, that had ferried the ryot across the Ganges; stern-wheelers, that had taken the tourist up the Nile; London County Council boats, that had carried the cockney on the Thames; Irrawady boats



MESOPOTAMIAN THEATRE OF WAR.

Scale 1 Inch = 32 Miles.

from Burma; harbour tugs from Rangoon; all now painted the same light grey, each with a couple of barges, toiling up and down. Their numbers were constantly being increased, but none of those specially built in England for the work had yet arrived, and the cry was always for more.

The advanced base at Shaikh Saad was a large, long camp on the right bank, with a tiny uninhabited Arab village tucked away in one corner of it,—aerodrome, hospitals, rest camp, troops, ordnance, supply depôt (largely supply depôt), a bridge of boats, and a bridge-head on the other bank; the whole protected on the landward side with defence posts and continuous barbed wire. To a new arrival the general impression of the place—besides dust—was of innumerable gangs of khaki-clad men slowly carrying boxes and bales from barges and dumping them on the foreshore. Sometimes they were fatigue parties, but usually they were coolies—men of the porter corps. No Arab was allowed within rifle shot of the place (though he often crept in, uninvited, at night, to steal—and occasionally to stab), and all the work was done by the force. Though the labour and porter corps were steadily increasing, there was not then, nor for a long time, enough labour to supply the various demands; every cooly might almost be said to be fought for among the many departments demanding his time. But all this was on paper, the actual individual went on quietly carrying his box of biscuits to the shore, or his basket of earth to the bund, without showing any particular concern.

Having completed the journey to Shaikh Saad, a report was made on the possibility of importing potatoes and onions from India. Various attempts to do this had been made in the past but without success; nor was this to be wondered at, judging by the stories of the men on the ocean-going steamers and the river craft. The potatoes had been packed in sacks, treated as ordinary cargo, and placed in the hold, sometimes with other goods on top of them. They then had to be transhipped at Basrah, first to the shore and then to the barges, where they were again heaped up. I was assured that in some cases they were half rotten before they left India, they were certainly often bad before they reached Basrah. It was,

therefore, suggested that potatoes should be carefully selected and picked over in India, packed in crates, kept ventilated and unbruised, treated as perishable goods, and sent up the line with despatch, when it should be possible to supply the force, without a prohibitive loss, for the greater part of the year. One or two other letters and suggestions were submitted on the subject, and the authorities in India took the matter up. The result was a very great improvement, so that even in the heat of June 1917, potatoes were arriving as far up the line as Samarrah, 70 miles above Baghdad, with a loss of less than 50 per cent. in transit ; a journey which, measured in time, is probably the longest that potatoes have ever been sent in large quantities. A loss of 50 per cent., however, was too large to make it worth while importing potatoes during the hot weather, and the export from India was stopped during May ; it being arranged that in future potatoes should not be shipped between the end of April and the middle of September. Onions were received throughout the year but, as the local supply of fresh vegetables increased, the quantities were gradually reduced, and the importation ceased at the end of 1917. Though there was a very rapid improvement in this supply, there were, of course, mistakes at first (for example, furious wires were flashing about, in December because numbers of potatoes were still arriving crushed in sacks, in January because some harassed officer had sent them up the line in country boats, which took ten days to reach Amarah alone, where the potatoes arrived bad), but these were gradually almost entirely eliminated, and were due, as were similar incidents in other branches of the work, not to any difficulty in convincing those in authority of what was required, but to the impossibility of educating a large number of hard-worked and constantly changing juniors in the correct way of treating a travelling vegetable.

The advantage of a vegetable garden at Shaikh Saad had been realized for some time, and four and a half acres had been set aside latterly for the purpose, while two *noiria* pumps had been ordered. Four and a half acres, however, would not go very far, so fifty acres were selected, with some difficulty, for a farm. It was found impossible to obtain more than this, as the area had to be inside the

defences, and was further circumscribed by the camps and roads, and the salt patches so common along the lower Tigris. An oil-engine and pump, together with various implements, were ordered, and plans drawn up for irrigating and laying out the farm. I then proceeded down-stream to Amarah.

Amarah, actually a small place, is the most important town between Basrah and Baghdad. It is situated 112 miles by river below Shaikh Saad, at the junction of the Tigris and the Chahala canal. As at Shaikh Saad, the whole place was surrounded by block houses and barbed wire, but the local Arab was much more encouraged, as he was less obstreperous. True, he was instantly fired at if seen by the sentries outside the perimeter at night, while if he lived in the town he was encouraged to go to bed at an early hour, but during the day he was allowed to wander about almost at will, to attend to his own affairs, to occupy himself with his cultivation or to work for us in the depôt or on the roads.

A second canal, the Mashera, takes off from the Chahala just after the latter leaves the river. There are thus three streams (the Tigris, the Chahala and the Mashera) from which water may be raised to cultivate the land, irrigation from all three being by lift and not by flow, except when the river is in full flood. Several forms of water-lifts and pumps were in use : *noiria* pumps, a wheel with an endless chain of small buckets, worked by a blindfolded pony and a primitive wooden gear ; *chereds* (the *mhote* of India), large leathern bags with a trunk at the end, self-discharging, and attached to a diminutive pony or cow that raises the bag by going headlong down an extraordinarily steep incline ; even several oil engines and centrifugal pumps. The cultivation is a narrow strip on each side of the three waterways. Near the town a number of date groves, among these and on fields further out the land is put down under barley or wheat ; and in and out among the date palms were small patches of vegetables.

On October 13th 1916 a report was submitted giving proposals for carrying out the work which were much the same as those on which it ultimately developed. The area necessary to provide the vegetable ration for the force was very much larger than was

generally supposed, and all ideas that a few acres here or there would suffice must be abandoned. The fifty-acre farm at Shaikh Saad would be put under cultivation as soon as pumps, implements and men were forthcoming, but the main supply must come from elsewhere. If this was grown by military labour, it would require a large number of men, who at present were not available, besides pumps and implements. It was more advisable, therefore, to utilize Arab labour, and to extend the present vegetable cultivation in such places as Amarah and Ali-al-Gharbi, where irrigation facilities already existed, or could be increased on existing lines. To get the best results, however, besides the agricultural side, comprising the general supervision of the crops sown, it was essential that there should be prompt payment in cash for the produce when harvested. Again, as work with the aid of local cultivators, under existing conditions, would have to be undertaken some way behind the lines, it was of the utmost importance that the vegetables so obtained should be collected in one place as soon as possible after harvest, carefully packed, and immediately shipped to the front. The work itself is described below under the three heads, growing, collecting and transporting.

Growing.

There was a general idea that no vegetables were grown in Lower Mesopotamia before the war, and that, therefore, the Arab knew nothing of their cultivation. This was not the case. That there were few vegetables is true, for the marsh Arabs, and those in the smaller villages, contented themselves with a kind of mallow and other plants that grew wild ; and this applies to the poorer classes in the towns. But in Basrah, Amarah and Nasiriyah, fair quantities of vegetables were consumed by the inhabitants, though the number of men with experience in their cultivation was limited. In order to increase the production several difficulties had to be overcome. First, and most important, it was necessary to convince the landholders that vegetable-growing would pay, and that it was to their advantage to put their energies into this as much as into their date gardens. Secondly, labour was scarce ;

Amarah was not a large place, and the roads, railway, and other works, created a ready market at higher rates than the landholders could afford. Thirdly, heavy irrigation was necessary, and water-lifts or pumps had to be provided in addition to those already in use. Fourthly, seed was required. Lastly, the time for sowing the cold weather crops was rapidly passing.

A meeting was immediately called of all the men having land in the neighbourhood, and they were told that a very large increase in the area under vegetables was required, and were assured that all vegetables produced would be bought, if delivered in good condition. Their objections and difficulties were listened to, and, where necessary, further considered on the land and, if possible, removed. They were also informed that Government would look with favour upon those who showed a large increase, while those who did nothing rendered themselves liable to punishment. As far as this threat was concerned no action was actually necessary, though one or two men had to be warned again later on, and one man in particular, who owned an oil engine and pump which he seldom used, was told that if a stated portion of his land was not under vegetables within a given time, his pump would be bought for a price named and sold to a man anxious to use it ; his land was then sown. Two or three other meetings were held at intervals, and care was taken to impress upon all that the matter was to their advantage as well as ours.

The agricultural work resolved itself into constant visits to the men in their fields, and in this I received very valuable assistance from Sergeant Wimshurst. Wimshurst was a student at Wye when war broke out, and enlisted in the 1/5th Buffs, was wounded at the battle of Shaikh Saad, and later employed at the base where he learnt Arabic. He was transferred to me on November 15th 1916 and shortly afterwards promoted to sergeant. Towards the end of 1917 he was granted a commission at my request, and became an agricultural circle officer under the new arrangement. I am glad to take this opportunity of recording his useful work. As he was in Austria in 1914, and only reached Holland on the morning of August 4th, it was unfortunate that the enemy could not be informed

of the potential Turk-killing power (by means of men saved from scurvy) that had slipped through their fingers.

Advice and help was given to the growers, principally with the object of obtaining better results from their existing means, increasing these, and insuring as far as possible a succession of crops. Little help could be afforded in labour difficulties. In this, and similar cases, we could only say (if I may put it so) that, had the campaign been waged in order to provide the force with vegetables, it would have been easy to supply them, but the issue of vegetables was only a small, though momentarily an unduly important item in the business of enabling the campaign to be waged. Comparatively little seed was distributed; the growers were suspicious of Indian seed and preferred their own, which dribbled down from the north. How it came I do not know, nor did I enquire too carefully, lest I should draw undue attention to the fact (the blockade was not my business, and the seed was coming in, not going out), but when it was wanted it usually came. An imported oil engine and pump, which were available at Basrah, were sold to one of the most enterprising of the cultivators and several *noiria* pumps were disposed of in the same way. Wood, which it was almost impossible for the Arabs to procure, was supplied for *chered* rollers and *noiria* gears. A small two-acre garden was started as an object lesson in good clean cultivation. All this caused a substantial increase in the out-turn, which would have been larger had we been able to start earlier in the season, and had the XIII Division not occupied the greater part of the lift-irrigated land on the left bank above the town.

Besides Amarah, similar measures were taken at Ali-al-Gharbi, Mudelil, Qalat Salih and Qurnah. Ali-al-Gharbi, $79\frac{1}{2}$ miles by river above Amarah, and 42 miles below Shaikh Saad, received particular attention and a pump, as it was the most northerly village where Arab cultivation could be used. The total out-turn was much less than at Amarah, as the inhabitants were few, but the proportional increase was greater. Mudelil and Qalat Salih produced enough for their garrisons. Qurnah made a good return, and, when the Qurnah-Amarah railway was opened, sent vegetables to Amarah, which were issued locally and released others for the front.

The following table gives the weight, in pounds, of the fresh vegetables purchased for the troops.

	Previous monthly average	Dec. 1916	Jany. 1917	Feb. 1917
Bought in Amarah ...	210,755 (1)	613,101	490,488	728,335
Out-turn from Amarah Garden ..	Nil	Nil	9,357	7,850
To Amarah from Qurnah ...	Nil	Nil	6,866	173,012
Bought in Ali-al-Gharbi ...	48,388 (2)	120,377	95,804	149,641
Total ...	259,143	733,478	602,515	1,058,838

(1) Average for 6 months April-September 1916 } There were no records of
(2) Average for 3 months August-October 1916 } previous purchases, if any.

It would be interesting to compare these figures with the returns for the cold weather 1915-16, but there were few vegetables and no records then; on the other hand, the out-turn per acre is, on the whole, larger from hot weather than from winter vegetables.

In addition to the work with the Arabs, various attempts were made to encourage direct cultivation by units at all places on the line of communication. The results, however, were small, nor is this to be wondered at under the existing conditions. The marching posts, at intervals of ten miles, were kept busy mounting guard and escorting, and the personnel, both at these and the larger places, was constantly changing. The best results were obtained at some of the hospitals. The first thing done at Shaikh Saad was to get boxes of cabbage seedlings sown by the seven *malis*, to be transplanted into land which two hospitals prepared. At Amarah at least three hospitals had already laid down good vegetable gardens, and arranged for their own seed, others followed their example. By one means or another, a fair amount was produced by direct cultivation, though much seed was unavoidably wasted. Unfortunately I have no definite records of the results, those that I have show that seed was distributed to seventeen hospitals, posts or units,—and there were certainly others.

COLLECTING.

Formerly vegetables had been purchased through a contractor, and very little enquiry proved that (like most contractors) he made large profits. But it will be remembered that my first proposals demanded prompt payment in cash and the abolition of contractors as an essential part of the scheme; and this was arranged for by what became generally known as the Amarah market.

For this a convenient site was selected in the corner of a yard surrounded by a wall and situated near the river bank, where two open sheds, 84 feet long by 16 feet wide, were erected on an existing earthen plinth, and roughly floored with country bricks. There was no particular reason for these dimensions, except that they suited the available space and material; all that was required was protection from the sun and rain.

The idea was very simple. Previously about 3,000 lb. of fresh vegetables had been sold daily in the bazaar to the inhabitants, and the remainder bought by the contractor and delivered to the S. & T. It was now made a penal offence for anyone who brought vegetables into the town to take them anywhere except into the market, and the police were instructed accordingly. Here they were examined, weighed, and bought at varying prices fixed at monthly intervals. What we did not require, or not less than 2,000 lb. a day, were taken out again and sold in the bazaar to the general public.

It was hoped that the market would have been ready by the end of November, but owing to various delays, lack of labour, scarcity of material (one shed fell in directly the roof was put on: wood had to be imported, so those responsible cut down the factor of safety as much as possible,—and sometimes overdid it), it was not completed until the middle of January, and opened on the 21st of that month. Sub-conductor Costello S. & T. was in charge, with a sergeant and pay clerk under him, and ran it well.

There was one item of the market's furniture that deserves a paragraph to itself: the cash-register. From hazy recollections of London shops, it seemed that a cash-register used backwards, would be some check on the payments. That is, the clerk would start the

day with a fixed sum in the drawer, and on payment being made, the register would be put through all its tricks, ring a bell, hoist the figures, and jot them down on paper, but the money would be taken out, not put in. Accordingly one was ordered. Unfortunately it arrived after I had left for Baghdad, and I never saw it,—I believe the clerk was afraid of it, and it was only used a few times. However, I feel certain that it was the first cash-register in Mesopotamia.

The advantages of the market were obvious. The large profits previously made by the contractor were divided between the government and the growers, to the advantage of both. The vegetables sold in the town were the worst, not the best, as had been the case when the contractor received a fixed price for all. The growers were more careful to bring their produce in rapidly, as damaged goods were paid for at reduced rates. There was little extra expense; the number of coolies employed in packing, weighing and shipping, was proportionately the same as that necessary to handle the vegetables when delivered by the contractor, and a sergeant had always superintended this, thus the only permanent extra was the pay of the sub-conductor and the clerk.

The actual figures are as follows:—

Cost of erecting the market, Rs. 4,793-8-0. This was very high, and was due to the excessive cost of the imported material and the inflated wages of labour.

The amount bought from the contractor during the 20 days, January 1st to 20th, was 220,135 lb. The amount bought in the market during the 11 days, January 21st to 31st, was 270,353 lb. That is, an average increase of 13,570 lb. a day.

Had these 270,353 lb. been bought through the contractor they would have cost Rs. 16,897-1-0; but they actually cost Rs. 10,335-8-0, a saving of Rs. 6,561-9-0. The market, therefore, produced more vegetables at less cost, and more than paid for itself in the first eleven days.

TRANSPORTING.

The transport of fresh vegetables from Amarah to the front had not been very successful. They were sent up on a barge which left

twice a week and usually stopped to deliver rations at the posts *en route*. This, in addition to a slow journey, necessitated the contractor and the authorities saving all surplus on the intermediate days, for shipment on the day on which the barge left. The vegetables were packed in sacks or open baskets piled one on the other, and the loss from crushing and delay was very great. An open barge with shelves was first selected, so that the vegetables were not heaped up in one mass, but this was not sufficient. Reports showed that there was still over 50 per cent. loss in transit.

The best course in the circumstances would have been to organize a special service of fast steamers, so that one left each evening carrying the vegetables received that day, properly packed in crates. This, however, was never attained, the real reason being that boats could not be spared. Nevertheless, considerable improvement was effected. Crates were procured from India in planks, nailed together locally, packed in the market and as many of them as possible placed on passing steamers, almost all of which stopped at Amarah. Similar measures were taken at Ali-al-Gharbi. By these means the amount of loss in transit was considerably reduced, though it remained an ever present trouble.

What proportion of the requirements was the 1,058,330 lb. produced in February ? At the end of January the ration strength of the force at Amarah and above was 50,738 British and 90,389 Indians, and the weight of vegetables required during February was, therefore, 2,058,330 lb. of which we were producing over half, in addition there were the vegetables produced by direct cultivation, and those supplied in Mudelil, which are not included. But, as explained above, there was considerable loss in transit, so that, while the XIII Division and the troops on the line received full rations, the men at the front got less than half, and those furthest away less still. Had the position remained unaltered, there would have been a further improvement during the next season, operations could have been commenced in time ; a Sheik near Ali-al-Gharbi was about to put down a large area ; a Jew was found, who was willing to arrange another large section near Kumait ; pumps capable of irrigating several hundred acres had been ordered for a Sheik near

Amarah. But all these, and other plans, were abandoned on the advance.

II. During the advance.

Everyone knows the chief features of the advance from the Sannayat-Sinn position to Baghdad, and beyond. The steady fighting up the right bank during part of December and January, the Shumraon crossing, the retreat of the Turks, and the entry into Baghdad on March 11th 1917.

An anxious time, probably, for many people, besides the Turks—certainly for the agricultural section. That which one hoped for, yet in one way dreaded, had occurred; the troops were running away from their vegetables, which could not be picked up and carried along behind. The only thing to do was to follow the army up anxiously scanning the banks for likely places for farms, and feverishly cross-examining Arabs as to where vegetables could be obtained. All the replies pointed to Baghdad as the only hope. It all came right in the end—but what if the army had not reached Baghdad?

III. Baghdad and beyond.

Arrived in Baghdad, the first essential was to estimate the vegetables in the neighbourhood; a difficult thing to do with any exactitude. Cultivation of all sorts had decreased during the last two years, and, at the moment, numbers of cultivators had cleared off, through a not unnatural desire to get out of the way of the war. There seemed, however, to be more vegetables on the ground than we had left behind in Amarah—which was so far to the good.

It may be thought that our difficulties had settled themselves; but they had not. In the first place, the quantities grown at Amarah were not enough, as has been shown. In the second place, Amarah was a small town and the requirements of the population comparatively negligible; but Baghdad, on the other hand, was a large town, the inhabitants of which were used to cultivated vegetables and consumed considerable amounts. Again, owing to the needs of the army, and the dislocation of many of the

ordinary channels of supply, certain of their usual sources of food were reduced or almost entirely cut off, while prices rose at once; so that the people were driven more and more to depend on locally grown vegetable food. In fact the scarcity became so great that the military organization had to import grain for the civil population; an additional strain on the long and severely taxed line of communication already burdened with the supply of the force. But that is another story. From our point of view reliable estimates of the vegetables available were at all times almost impossible to compute, for, not only had the constant movements of the troops to be considered, but allowance made for a varying and unknown factor, the requirements of the town.

There were, then, not enough vegetables to supply both the troops and the town, and it was necessary to start again on much the same lines as at Amarah, telling the people that large quantities would be required, and helping them to get those quantities grown. For the moment, however, no one knew who were the owners of much of the land, or where they lived—though the authorities were rapidly finding out. As an immediate step Sir Percy Cox kindly circularized his Political Officers and some of the well-known landholders near. Gradually in one way or another the men were told, and the effort started. Our strongest card was to point to the money made by the cultivators at Amarah, a fact now for the first time plain to the inhabitants of Baghdad. The most cursory enquiry at once brought up the question of the pumps, a difficulty that was always with us. I have said that there were a few oil engines and pumps at Amarah, but, the number being small, it was an easy matter to supply them with oil. At Baghdad, however, there were hundreds dotted along the river banks. In a few months we had over 270 on our list, the majority within five miles above or below the town. The owners of these engines had had increasing difficulty in procuring oil since Turkey joined the war; the price, formerly from one and a half to two rupees a tin, had risen to a Turkish pound. After our occupation there was none, and, unless it were supplied almost at once, crops which were irrigated by the pumps would die. Some of them did die, and others were severely

checked; but luckily the general total slowly rose owing to an increase in the number of *chereds*, and extra sowings by men we supplied with oil.

This sudden demand for oil caused much anxiety. It could be obtained from the Anglo-Persian oil fields below Basrah, but had to be brought up the line, which was already overworked, and its transport would take time. Various temporary measures were adopted. A little was captured in Baghdad, of which I obtained 500 gallons for the pumps. I begged 548 gallons from the Camp Commandant at G. H. Q. I was given 2,000 gallons from the ordinary S. & T. supplies. Then we began to receive larger quantities from the oil *mahalas* coming up the river. But by April 25th only 9,064 gallons had been distributed, as against my estimate of forty to fifty thousand gallons a month required. No wonder the crops were looking bad. It was nobody's fault, of course; even the most exacting would hardly expect an army, at the end of a sudden and rapid advance, to produce on demand large quantities of oil that no one knew would be required.

It was not enough, however, to bring the oil to Baghdad, it had to be distributed to the cultivators. The first 500 gallons were given to a few men present at the time, who I knew had pumps and crops. The next 2,252 gallons were carted to a godown lent by the First Revenue Officer, and distributed, with the help of my interpreter and a small Arab youth who proudly answered to the name of clerk, to men already on our list. The confusion was immense, crowds clamoured round the godown hearing that oil was for sale. Things could not go on like that, but, luckily, as I was endeavouring to get a proper staff, Mr. Wilson of Strick Scott's firm arrived. He had been in Baghdad before the war, and, among other things, had dealt in oil. An agreement was made with him whereby he received and distributed the oil, kept the books and collected the cash, receiving as commission ten per cent. of its cost price to Government. It was only issued to men on our list, and on an order countersigned by the Director of Supply and Transport or myself. This arrangement worked very well until after the period covered by this report, when, with the increase of the

department and the extra men employed, it was possible to make other plans.

Before Mr. Wilson's advent, and even afterwards for a time, I was harassed by crowds of Arabs—varying from the sullen and indignant, through the dignified and grave, to the pathetic and almost tearful—all clamouring for oil. They followed me about, and invaded my room at all hours of the day, and sometimes sat outside at night. For the most part they were quite reasonable, and realized we were doing the best we could. Gradually the lists were completed, and the proportion due to each adjudged.

But our troubles were not over. Even had we had the most perfect methods of distribution we must have had trouble as the amount available did not meet the demand. In April the authorities agreed to supply fifty thousand gallons a month, the quantity then estimated to be enough. By August the requirements had increased, owing to the hot weather, the greater quantity of pumps in use and of land under crops, and the estimate had to be raised to eighty thousand gallons a month. But, far from increasing our supplies, the original fifty thousand gallons could not be delivered. Some actual figures are:—for July, 36,868 gallons; for August, 54,572 gallons; for September, 34,448 gallons. It was obvious that crops were suffering, and discontented cultivators once more appeared. The river was low, oil barges few, and difficult to get up, while extra supplies were wanted, to light the town, work ice plants, for sanitary use. Special efforts were made to accelerate delivery; while soon, owing first to the cooler weather, later to the rain, less irrigation was required and less oil was in demand.

An interesting sidelight was the small amount of water actually necessary to keep a plant alive. I wish I had been able to get figures of water supplied and crops produced—they would, I think, have startled irrigation experts here.

In addition to procuring burning and lubricating oil, it was necessary to provide repairs. Shortly after we arrived, the First Revenue Officer found six men for me who had worked in repairing shops before the war, and an attempt was made to make use of them. It proved impossible to work them as a controlled concern,

spares were difficult to get, and materials were not available for a shop. Again a stroke of luck! An old Arab, an excellent "mistri," was found, who, with a little semi-official help, carried out the work himself. He bought (and, possibly, found) spare parts from those who had them, or whose engines had been broken by the Turks, and collected his own break-down gang. Passes were given to him and his men to enter and leave the town, and belts and spares occasionally bought for him from Works. All the same, clever though he was, he could not manage serious repairs, and his resources steadily became less; so suggestions were made that the repairing work should be undertaken by Works, and in September 1917, a letter was put up to the D. S. and T. making definite proposals. Eventually Works took over the whole, but after the period of these notes.

Most of the pumps were near Baghdad, but there were a few at other places in the forward area and dotted down the line. These received oil from the nearest supply depôt on instructions from headquarters, and the number dealt with thus increased as the country became more settled.

At first our principal agricultural work was in the neighbourhood of Baghdad, but a considerable amount was done at other centres, such as near Baqubah, Fallujah, Samarrah and Ramadie in the forward area, and at or near almost every station down the line. The methods adopted were much the same as those already described at Amarah, and our object was to get the Arabs to grow the requirements themselves.

Sergeant Wimshurst came to Baghdad in May; and Lieutenant Cheesman ably superintended the work on the lower L. of C. after the Madras garden corps arrived and relieved him of the Shaikh Saad farm.

A particularly neat arrangement was carried out with the help of the VII Division at Samarrah, whereby cultivation was encouraged in their area, and even beyond our lines, in spite of the presence of two hostile armies. Major MacMahon, their D. A. A. and Q. M. G., took a lot of trouble over this. The XV Division, with Lieutenant Cheesman's advice, did much to encourage production at Nasiriyah,

and later at Ramadie. In fact, once the methods were explained, the work was taken up on all sides.

The most unfortunate place, and the one most difficult to supply during the hot weather, was Basrah. Efforts to increase the cultivation of vegetables in that neighbourhood did not meet with much success, owing to labour difficulties and probably to lack of expert advice. It should have been possible to make up their deficiencies with vegetables from Amarah and Qurnah but, with the transfer of Sergeant Wimshurst and myself to Baghdad, the purchases in these places fell off considerably (February, 901,347 lb.; March, 658,280 lb.; April, 332,920 lb.; May, 504,000 lb.), while proper arrangements, apparently, were not made for sending the supplies down stream. Later, however, I transferred Lieutenant Cheesman to Amarah to reorganize the supply.

Gardens run by the troops themselves seldom reduced the ration demands, principally because a unit rarely remained in one place for a sufficient length of time; but three gardens in particular gave good results, at Nasiriyah, Fallujah and Ahwaz, while small amounts were produced at Diyalah, Ctesiphon, Baghailah, Aziziyah and elsewhere. Vegetable seed was given to all units on demand until September 1917; but then free seed was no longer necessarily supplied to units in places where sufficient vegetables were known to exist. The following amounts, in pounds, were issued (the figures in brackets are the weights received from India):—Beans, broad 1,547 (5); beans, French 71 (60); beans, haricot 1 (5); beans, kidney 814 (0); beetroot 473 (379); brinjal 345 (57); cabbage 112 (295); carrot 249 (113); cauliflower 33 (114); chillie 38 (23); cucumber 1,333 (152); gourd 407 (414); kohl rabi 34 (38); lady's fingers 1,305 (604); lettuce 61 (21); melon, rock 18 (18); melon, sugar 275 (0); melon, water 878 (30); onion 1,063 (95); peas 52 (59); pumpkin 112 (57); radish 601 (6); spinach 773 (314); tomato 120 (25); turnip 407 (133).

The above are the majority of the seeds distributed direct, and were supplied to units, Arabs (most of whom, however, found it cheaper to procure their own), and our own farms at Shaikh Saad and Baghdad.

The seed sent from India had a long and difficult journey, and the germination of a few of the samples that arrived was *nil*.

As against this, however, it became more and more easy to obtain seed in the country (some of the varieties were called Damascus and some Stamboul—whether or not they really came from there I do not know); and, on the whole, the country varieties did better than the Indian.

The Shaikh Saad farm, as recorded above, was fifty acres, taken up immediately after I came out. When I first left there for Amarah, Lieutenant Cheesman, I.A.R. (formerly of Wye, and then 1/5th Buffs), was detailed as my assistant and went to Shaikh Saad to organize the farm, arriving there on October 26th 1916. He had many difficulties to contend with, due to scarcity of labour; but gradually implements, a pump and a small staff (an Indian officer, 3 British privates, about 30 Indians and 24 bullocks) were collected, and at the end of the year I was able to send him Sergeant Aldridge, an excellent practical gardener, also of the 1/5th Buffs (the agricultural section might almost be described as an offshoot of the Buffs—proving the prowess of the men of Kent in agriculture, in addition to other directions!). Much spade work had to be done before the farm began to produce; its first returns were 402 lb. in March and 3,980 lb. in April 1917. The difficulties were reduced when the Madras garden corps arrived in May.

This corps, if I remember rightly, was first offered by Madras in November 1916. Under the then conditions, I suggested that enough men be asked for for the Shaikh Saad farm and a similar farm at Arab Village or elsewhere; and a telegram to that effect was sent. The personnel eventually despatched was 2 British officers, 2 British N. C. O.s, 1 sub-assistant surgeon, 1 clerk, 4 head *malis*, 24 *malis*, 220 coolies, 3 *bhisties* and 3 sweepers. Unfortunately they were only enlisted for a year, and did not arrive until May 1917, when the conditions had entirely changed. I placed about half at Shaikh Saad, and the remainder on a farm at Baghdad. They produced good crops while they were out, but left in February 1918 on the completion of their year. The figures of the cost of the vegetables they produced proved the wisdom, even from economy alone, of

confining our efforts, wherever possible, to production by the Arabs. For example, the cost of the vegetables produced on the Baghdad farm, from the time of the arrival of the corps on May 24th, to the end of September (excluding the cost of rations, tents, clothing, implements, seed, et cetera, and $3\frac{1}{2}$ months' pay while coming out) was 2·3 annas, as against the contractor's price of 0·88 anna a pound.

Fruit, with the exception of melons, was beyond the powers of the agricultural section. There were fruit trees (oranges, limes, mulberries, apricots, figs, pomegranates, each in their season, in larger or smaller quantities) at Baqubah, Baghdad and elsewhere; but it was useless to try to increase the immediate supply, and improvements in pruning and so forth could only have been introduced slowly by a large staff. It was possible, however, to increase the area under melons, and this was done. The ration was 2 oz. daily of fruit, either fresh or tinned.

Notwithstanding the success of the Amarah market, the new purchasing department was averse to starting similar concerns elsewhere—at Baghdad, I believe, because of the size of the undertaking, and at other centres, because the position had become easier, and contracts were preferred.

Transport difficulties were considerably reduced. The troops were spread out, instead of concentrated in one spot; while railways from Baghdad to Samarrah, Baqubah and Fallujah, combined with motor transport, rendered the distribution comparatively easy, especially as each centre became more nearly self-supporting.

Results.

The following table gives the quantities in pounds purchased and supplied from the larger farms:—

Month 1917	Line of communication	Forward area	Shaikh Saad farm	Baghdad farm	Total
April	640,920	713,720	3,980	nil	1,358,620
May	909,440	892,080	7,963	nil	1,809,483
June	1,624,840	1,514,240	25,065	nil	3,164,145
July	1,906,520	2,054,640	46,773	1,829	4,009,762
August	1,958,600	2,173,640	47,000	61,893	4,241,133
September	1,942,080	2,705,360	57,647	79,391	4,784,478
October	1,826,160	2,551,640	50,219	76,536	4,504,555
November	1,294,440	2,174,200	79,960	23,135	3,571,735
December	2,336,575	2,556,794	149,759	27,139	5,070,267

The rise in the above returns for June may fairly be taken as proof of the efficacy of the work in and around Baghdad and on the upper L. of C., from the time of the capture of the town. The contractors began to deliver our full requirements in Baghdad from about May 25th.

The following table shows the relation between the vegetables supplied, and the amounts required for the daily ration of 12 oz. for British and 6 oz. for Indian ranks :—

Approximate ration strength on (1)	British	Indian	Weight required during the month, pounds	Weight supplied, pounds	Excess (+) deficit (—) pounds
September 1st ...	88,965	238,405	4,683,768	4,784,478	+100,710
October 1st ...	101,305	265,562	5,442,499	4,504,555	—937,944
November 1st ...	107,785	278,420	5,557,387	3,571,735	—1,985,652
December 1st ...	121,773	315,128	6,494,585	5,070,267	—1,424,318

(1) The ration strength is the whole Expeditionary Force, including Medical, I. W. T., Labour corps, followers, et cetera.

Under conditions such as described, a renewed shortage was almost inevitable when the force was increased (in terms of vegetables required), by nearly 40 per cent.; but the supply was gaining again on the demand by December, and the shortage was never as bad as it seemed, for two reasons. Firstly, when massing the figures in this way, no account can be taken of those troops who, owing to operations, movements, and so forth, could not be supplied temporarily; but their numbers were sometimes large. Secondly, the potatoes and onions imported from India are not included. I have not got any figures here, except those showing that in December 785,557 lb. of potatoes and onions (more than half the deficit) were issued on the lower L. of C. alone, from Basrah to Kut inclusive.

There was another amusing proof that the vegetable position was practically secure. In the early days the average man was delighted if he received a somewhat damaged turnip, or even wilted turnip tops. Towards the end of the time complaints began to be heard. "We do not want lady's fingers, we do not like them, and we are tired of brinjals too," said the army, in effect, "why not give us cauliflowers or cabbages or peas?" Or later, in the cold

weather, "nothing but turnips"— or beetroot, or lettuce, as the case may be. It was little use explaining that cauliflowers or peas could not be grown in the hot weather, or that it was necessary to concentrate on the higher yielders among the vegetables known to the Arab,—they simply did not believe you. And personally I sympathized, I never liked hot weather vegetables myself.

The ultimate test for the results, however, must be sought in the scurvy returns, as the principal reason of the ration was its antiscorbutic effect. This is shown in the table below which compares the numbers of scurvy cases admitted into hospital for the whole force during the hottest months of 1916 and 1917.

Month	Number of cases 1916	Number of cases 1917
July ...	2,465	339
August ...	3,395	211
September ...	2,990	168

During this time the ration strength had approximately doubled, the proportion of admissions, therefore, had fallen by over 95 per cent. A proof that the vegetable ration was the chief, though not the only, means for combating the disease, is that 46 per cent. of the remaining cases occurred in Basrah, the place most undersupplied.

SOME FACTORS WHICH INFLUENCE THE YIELD OF PADDY IN COMPARATIVE MANURIAL EXPERIMENTS AT THE MANGANALLUR AGRICULTURAL STATION.*

BY

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THE Manganallur Agricultural Station is situated in the Tanjore delta, and is devoted to the study of wet land or swamp paddy. This crop is grown in fields enclosed by earth "bunds" or ridges to hold in the irrigation water, and the fields are each about one acre in extent. The soil is a heavy clay, such as one would expect from deposition of fine silt in standing water. Analyses show that 65 per cent. of the soil consists of clay and fine silt.

The following outlines the method of cultivating the crop. The sprouted seed is sown in a manured seed-bed, which is prepared by ploughing under water (puddling) and carefully levelling with a board. Shallow drainage channels are made at intervals across the seed-bed to drain off superfluous water. When the seedlings are about 40 days old, they are pulled out and carried to the field which has been prepared by puddling and levelling, and here they are singly planted out at intervals of about 9 inches. In a few days these strike fresh root, and subsequent operations consist of weeding

* This article was originally intended for the Madras Year Book, but the writer felt that this question of the study of field experiments, not only in the case of manurial experiments with paddy, but with practically all field experiments, was of such importance that it might gain wider publicity in the *Agricultural Journal of India*, and that other workers might reciprocate in giving their experience of similar observations in the case of other crop experiments in India. [H. C. S.]

once, or twice if necessary, and regulating the supply of irrigation water which is maintained at a depth of 3-4 inches. Irrigation continues until about two weeks before harvest, when the water is drained out and the field is allowed to dry.

Manurial experiments are of two types. Those which are designed to test the effect of a manure on the succeeding crop *i.e.*, a single application of manure, the results of which are recorded in the yields obtained, and the experiment is concluded. In the other type, the same manure is annually applied to the same plot to ascertain the cumulative effect of the manure. In this latter case one has not only to compare the yields obtained in the one year but also to compare the yields obtained in one year with those obtained in another.

If such experiments were absolutely under control, then the results obtained from duplicate or multiple plots under the same treatment should always agree in any one season, and it is these factors which cause variation in yield between plots receiving the same treatment and which are now under discussion.

The first type of experiments, namely, those concluded in one season, is likely to give much more accurate results, but they give much more meagre information, and their scope is strictly limited. Many more factors in this case are under control.

The seed used in the seed-bed is the same. If the seed-bed is properly prepared, and if seedlings along the margin and the drains are not used, it is possible to get seedlings all of the same age and quality. The planting of all the plots can be completed in the same day. Irrigation and surface drainage are the same. It will, however, be found that no two plots under the same treatment will ever give the same yield, and if the experiment were repeated the following year on the same field, it would be found that the results obtained would be different from those obtained in the previous year. These differences in yield are due to factors which are beyond control.

In the first place, it is impossible to get land of even fertility, and this is more difficult probably in the case of swamp paddy than with any other crop. When the land is ploughed under water, a

great proportion of the debris of the previous crop floats to the surface, and the wind will blow this to one side of the field. If there are regular prevailing winds, then the side of the field opposite the direction of this wind is always more fertile. In this case the south-west monsoon winds are blowing when the fields are ploughed, and the north-east side or corner of the field is always the most fertile. Such crop debris is also apt to clog on the plough, and where this drops off or is removed, the soil is enriched at that spot. In levelling the field the surface soil is drawn from the higher to the lower levels of the field, and, when level, such portions which were originally lower are inclined to be more fertile. The texture of the soil is also affected by irrigation. Around the water inlet, where the flow of water into the field is rapid, much more coarse soil particles are deposited, while the farther away from the inlet, the less will be the flow and the finer will be the sediment deposited. Thus, even though care has been taken to standardize the field by harvesting the previous crops in small areas, a further error is always liable to creep in from the ordinary cultivation operations in the field.

Weeds again are another source of error. If the field is not uniformly levelled, and the water is not kept to a sufficient depth in the field, rushes, sedges and other semi-aquatic weeds are bound to spring up wherever the soil is exposed. The debris blown to the side of the field also contains large numbers of weed seeds and *Marsilia coromandaliana* may be mentioned as one which is often troublesome. " Veppam pasai " (Tam.) [*Chara*, spp.] is also a very troublesome aquatic weed which may greatly check the growth of the paddy. This is much more likely to affect the unmanured or check plots, because these are always backward in becoming established, and this weed which requires full sunlight will often get a hold here, while on the manured plot it may be suppressed. When once it has got a firm hold it is very difficult to eradicate, and as it keeps the growth of the crop in check, it will materially lessen the yield. Thus the difference in the yield of the manured and the unmanured plot may be much greater on this account than if this weed were not present. It may be said that such difference should

be credited to the manure. In ordinary farming it can be, but in an experiment it must be discounted, because there is no guarantee that every field has this weed present.

The season also may affect the yield of different plots. Heavy rains in the fallow period will cause these lands, which, when dry, have cracked both widely and deeply, to swell and more or less completely close these cracks. This is disastrous to the succeeding crop as it stops drainage and soil water movement through the soil ; not only this, but the soil below the surface becomes so compact that the roots of the crop are unable to use any but the surface soil. The efficiency of the cultivation is greatly decreased and only a shallow puddle can be procured. These delta soils though very uniform near the surface vary very considerably in depth. Those on this Agricultural Station rest on coarse river sand which may be a few feet or many yards from the surface. It is obvious therefore that the deeper the clay alluvium, the more disastrous are the effects of this check in drainage. In this way even parts of the same field may be affected differently. The same result occurs when irrigation water is let into the field and the field is then allowed to dry. If the water is kept continuously on the field then the drainage is not adversely affected.

The season may also affect the development of the grain. It has already been pointed out that the manured crop will often become established more quickly than the unmanured fields, and these naturally come into ear sooner. For example, a crop manured with superphosphate will invariably come into ear a few days sooner than a crop which is unmanured. A heavy rain at the flowering time will affect the setting of the grain, and one plot may suffer while the other escapes. In the same way a rain at harvest time may cause one of the crops to shed more than the other.

The question of the crop being laid may affect the yield. The straw of these delta paddies is invariably weak, and a manured crop, especially if manured with nitrogenous manures, may be badly laid, sometimes even before it has come into ear. Unmanured plots on the other hand will often remain standing until cut. If a crop is laid before the water is drained off the field, some of the

grain invariably gets damaged. Even if it is laid after the water is drained and the weather is dry, much more grain is shed during the operation of harvesting than is the case with a standing crop.

To ensure the greatest accuracy, therefore, it is necessary not only to multiply the number of plots receiving the same treatment and take the average results, but it is also necessary to repeat the experiment for several seasons and take the average of these. This, however, would involve a very large area of land, as it is obvious that a fresh area would have to be selected each year for each experiment on account of the manurial residue left in the soil.

The majority of manurial experiments, however, deal with the cumulative effect of manures when annually applied to the same plot. The type of experiment already discussed, deals only with the effect of quick-acting or soluble manures which show their results on the succeeding crop, and the causes which affect the yield of continuous experiments on the same land, besides including all and accentuating many of those already discussed, introduce many new factors which affect the yield. During the same season the control is just the same, but comparing the yields from season to season, only three factors can be definitely controlled, *viz.*, the shape and area of the plots, the quantity of manure applied, and the actual weighments of grain yield. Straw yields cannot be controlled, as the moisture content varies with the ripeness of the straw and the state of the weather. The seed may be of the same variety, but it may be of different quality, *i.e.*, germinative energy and capacity. The seedlings may be of different quality and age. The season may be early or late. If it is late, the effect of the manure, especially phosphatic manure, will be more marked, because late planting always affects the yield, and the crop becomes established sooner and matures sooner when manured with phosphates. The physical soil conditions, however, vary very much from season to season, and if the drainage is bad and the puddle shallow, very little effect of manurial treatment will be seen.

In the case of many manures, especially bulky organic manures, these in themselves greatly alter the texture of the soil, and the cumulative effect in this respect is often very marked and apparently

very variable. The effect of other manures applied in conjunction with such organic manures also varies greatly. For example, where an organic manure has been able to improve the texture of the soil, so that the season effects of poor physical drainage are counteracted—this may occur if the alluvium is not too thick—then other manures applied in conjunction with the organic manure may show marked increase in yield. If, however, the alluvium is deep and only the texture of the surface has been improved, a bulky organic manure is, under these anaerobic conditions of cultivation, liable to turn the soil acid. An acid manure, such as superphosphate, would in this case very probably do more harm than good in that particular plot, while the organic manure itself might also show a decrease in yield when compared with the check plots. The residual value of the manure in the duplicate plots would, however, be very different, and if in the next year the physical conditions of both plots are good, the yields will vary greatly.

It is thus evident that if plots are merely duplicated, it is impossible always to draw conclusions merely by studying the figures of yield. One plot may show an increase, while its duplicate may show a decrease. The continuance of the experiment over a number of years will give an average, but it must be remembered that the cumulative effect of the manure has also to be taken into account. The solution of the difficulty seems therefore to be in multiplying the number of plots under the same treatment and averaging the results.

Another factor which seems to be an insoluble difficulty in such permanent experiments is the formation of the plot or unit of experiment. There are two methods of doing this. Firstly, each plot may be separated from the next by a permanent earth bund or ridge; and, secondly, each plot can be marked by permanent stones and separated from the next plot by an unmanured strip. Neither of these ways is perfect. The objections to the former are :—
(1) It is difficult to get uniform cultivation and levelling. (2) Each plot has to be irrigated and drained separately. (3) The margins of the plot will invariably show better growth. (4) The crop is much more exposed to attack of crabs and caterpillars which the

permanent earth bunds will harbour. (5) Unless these bunds are high, they are very liable to break down during the cultivation season and not hold the water in the field. They are often submerged during heavy rains. If the bunds are high, the crop is not under normal conditions, as it is too much protected from the wind, and the soil from the bunds is continually being washed down into the field from which it has again to be lifted in the next season when the bunds are repaired. High bunds also leak very badly, as they harbour crabs and rats which riddle these with their tunnels.

The latter method is preferable on the whole because, (1) observation shows that soils, even under these swamp conditions of cultivation, receive and retain manures as soon as they are applied. Nitrates are an exception, but these do not come within the scope of manurial experiments with wet-land paddy. There is therefore little, if anything, to be gained in this respect by providing earth bunds. (2) It is possible to puddle each plot as a separate unit, but unfortunately it is not possible to level each plot separately, as the whole field has to be of the same level; there is therefore always a certain amount of mixing of the surface soil in the plot with the surface soil adjacent to it, and the residual value of previous applications does not entirely remain in the plot to which the manure was originally applied. Observation shows that this effect is apparent in the growing crop to a distance of 5 to 6 feet from the margin of the plot. It is necessary therefore to leave a non-experimental strip of at least this width between plots. (3) As regards irrigation, drainage, weeding, etc., conditions are uniform for all plots; while the danger of loss from the insect and other pests is minimized.

What has been written indicates the importance of maintaining careful observation notes of experiments and the danger that lies in merely judging the results of different plots by the figures of yields recorded. There are so many factors which induce error, and which are beyond control, that without such observation it is often impossible to draw any deductions of value from the yield figures recorded. Much has been written about the importance of estimating the probable error of an experiment. In any experiment concluded in one season this must form the basis of the value of the

results obtained; but in a continuous experiment conducted over several years on the same plots, there are so many factors which alter the original condition of the plots and so many factors which vary from season to season that, after the first year, the only method of gauging the value of the yields obtained is by the study of the growing crop in the field.

EXPERIMENTAL ERROR IN VARIETY TESTS WITH RICE.

BY

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INTRODUCTION.

ALL work on the improvement of crops, whether by the introduction of new varieties or by plant-breeding, requires constant comparisons to be made with regard to yield. Where large numbers of strains are being grown for comparison any increase in the accuracy or rapidity with which undesirables can be rejected results in a correspondingly increased efficiency in the work. A study of the experimental error involved in different methods of making these comparisons is, therefore, of the utmost importance, since the knowledge obtained makes it possible to handle, with any required accuracy, the maximum amount of material for a given set of conditions or resources.

During the last ten years, numerous investigators have drawn attention to the importance of experimental error in all types of agricultural experiments. This has had its effect in improving, very considerably, much of the work that is being done. There is still, however, room for improvement in a good deal of the work of which accounts are published.

It is not proposed to discuss the literature on this subject. Lists of references will be found in papers by Hayes and Arny[1] and Batchelor and Reed.[2] These include work on a large variety

[1] Hayes, H. K., and Arny, A. C., *Journ. Agric. Res.*, vol. XI (1917), no. 9, p. 399.

[2] Batchelor, L. D., and Reed, H. S. *Journ. Agric. Res.*, vol. XII (1918), no. 5, p. 245.

of crops, including fruit trees, under very varying conditions. The systems adopted by different workers, for reducing the experimental error to any required degree, vary very considerably according to the type of experiment, *e.g.*, whether manurial or variety tests, the quality and quantity of land available, the crop under experiment, etc.

It is proposed in this paper to refer briefly to experimental error in general, under Indian conditions, and to give, in some detail, the results of work on rice in Madras Presidency.

EXPERIMENTAL ERROR IN INDIA.

The experimental error of ordinary field-plots has been calculated by different workers for various types of cultivation in different countries. Although there is not as much variation as might be expected for the widely varying conditions involved, it would be impossible to apply any one figure to a given set of conditions without some preliminary investigation.

In order to get some idea of the range of error for various types of cultivation in different parts of India, an examination was made of the results of experiments given in the farm reports of different provinces. The *probable error* was worked out from the yields of duplicate plots as given in these reports. It was very common to find two distinct *series* of plots, of obviously different cropping value, described as *original* and *duplicate* respectively. Results from such separate series were carefully excluded. Apart from this, the figures employed were not in any way selected but were taken at random from any experiments that included a number of duplicates.

This is the same method as was employed by Wood and Stratton[1] in the case of results published in England. It should be noted, however, that the method of calculation employed by these authors (*l.c.*, pp. 436–7) is subject to a definite error. For each pair of plots they calculate the mean and the difference between each plot and the mean. These differences, after reducing to percentages of the mean, in order that the results of different experiments

[1] Wood, T. B., and Stratton, F. J. M. *Journ. Agric. Science*, vol. III (1910), p. 417.

may be combined, they then use for the probable error determination in the same way as they would use differences from the mean of a large number of determinations. In other words, they take differences between duplicates as twice the difference of one from the mean. Now the probable difference between any two results taken at random, such as duplicates, is $\sqrt{2}$ times the probable difference of any one from the mean. It is obvious that, in calculating the probable error from the results of duplicate plots, the difference between any pair should be taken as $\sqrt{2}$ times the difference of one from the mean. Their result for 400 pairs of plots, *viz.*, 4·2 per cent., should, therefore, be multiplied by $\sqrt{2}$, thus giving about 6 per cent. as the probable error for one plot, or 8·4 per cent. for the difference between two plots.

Except for this modification, the same "least square" method of calculating the probable error was applied. The results were worked out as the *probable error of the difference between two plots*, as it is such differences that most experiments are designed to show. As was to be expected, much variation was found when each set of experiments was taken separately. A critical examination of the figures, however, showed much about the same range of error for the different sizes of plots, about 4 to 25 cents, and for different localities. Table I shows the figures obtained for four of the most important crops, representing widely different types of cultivation.

TABLE I.

Probable error of ordinary field-plots in India.

Crop	No. of pairs	% Probable error between two	
Rice	240	13·0	
Sorghum	166	14·8	
Cotton	114	12·2	
Wheat	114	14·0	
Combined result ...	634	13·5	

The results for the different crops show surprisingly little variation. The combined figure, 13·5 per cent., for the probable

error of the difference between two plots, is not very satisfactory, being very much higher than the corrected figure of Wood and Stratton already referred to, *viz.*, 8·4 per cent. for ordinary experiments in England. It must be remembered that this figure is an average result, and there must be, as indeed the details show there are, many experiments with an error much higher than this.

WORK ON RICE IN MADRAS.

A detailed study of this subject has been made in connexion with work on rice in Madras. The probable error has been worked out for different sizes and shapes of plots varying from ordinary field-plots of over one-tenth of an acre down to lines of 20 plants.

Ordinary field-plots.

Under this heading are included such experimental plots, ordinarily in use on the farms, as have not been laid down in the form of specially long narrow strips. Table II gives details for a number of separate experiments on various farms.

TABLE II.

Probable error of ordinary field-plots of rice in Madras.

Farm	Experiment	No. of plots	% Probable error between two
Coimbatore ...	Standardization N Block	20 plots	13·0
,, ...	Pattimannu manurials	21 pairs	13·4
,, ...	Age of seedlings	8 ,,	13·6
Samalkota ...	Cyanamide manurials	20 plots	13·9
,, ...	Spacing	22 pairs	7·7
Palur	Bulky manures	72 ,,	11·3
Manganallur ...	Phosphate manurials	20 ,,	12·6
,,	Udu manurials	60 ,,	13·9
	Combined result	203 pairs 40 plots	12·3

The results are very uniform with the exception of one experiment, a spacing experiment at Samalkota, which, for some reason unknown, is very distinctly more accurate than the others. The

low figure for this experiment reduces the combined result to 12·3 per cent., though the other results suggest that about 13 per cent. would be more representative of ordinary conditions.

Long narrow field-plots.

Under this heading are included plots specially laid down in the form of long narrow strips with a view to reducing experimental error. They are large plots such as can be used for the majority of ordinary farm experiments, and are in quite a different category from the small strips, to be described later, for use only in variety trials. Table III gives data for a number of series of such plots.

TABLE III.

Probable error of long narrow field-plots.

Farm	Experiment	Area in cents	Dimensions	No. of plots	% Probable error between two
Coimbatore ...	B. Standardization	About 10	Length more than ten times breadth	18	6·0
Manganallur* ...	Fish	5		14	7·0
Do. * ...	Super	5		14	5·5
Do. * ...	Standardization	5	20 × 250 lks.	28	8·7
Do. ...	Do.	2·4	20 × 120 lks.	35	5·7

* For the figures on which these results are based I am indebted to Mr. Sampson.

It will be seen that the probable error of these plots is consistently lower than that of the ordinary plots, shown in Table II, by a considerable amount. It is obviously desirable that such plots should be adopted more generally where the nature of the experiment permits. A large departure from this type would very seldom be necessary.

Lines and small plots for variety-tests.

In working with transplanted rice it is comparatively easy to obtain a full stand of plants very evenly spaced. It was considered, therefore, that the method of testing strains by means of lines or narrow strips would be particularly useful for this crop. Experiments designed to test this have been carried out during several years, and have yielded some interesting results.

The first experiment was carried out, during two successive years, on the ordinary experimental area of the Central Farm, Coimbatore. The method was to divide a field, planted uniformly with one variety, into a number of very small units of regular size and shape. These units were harvested separately and their grain stripped by hand and weighed. It was then possible, by various combinations of units, to compare the yields of small plots of various sizes and shapes.

In 1913-14 one field was used, and in 1914-15 the same field again together with a neighbouring field of about equal area. These fields were planted very evenly at 9 inches apart each way. In each case, after removing a number of lines round the outside, a block of plants was obtained comprising 80 lines with 70 plants in each. The unit adopted was a double line 10 plants long, *i.e.*, 20 plants. The block was divided so as to give 7 columns each containing 40 units lying side by side.

The probable error was calculated for various combinations and arrangements of these units, each field being taken separately. It is not proposed to give the figures in detail but only the main results with the figures for the three fields combined. In the tables that follow the figures representing the size and shape of the plots indicate the *length* and *breadth*, respectively, *in plants nine inches apart each way.*

Some results for plots of various sizes and shapes are given in Table IV, which shows the probable error of the difference between two plots—(*a*) *adjacent*, (*b*) *any two at random*—in the same field.

TABLE IV.

Plot	PROBABLE ERROR BETWEEN TWO		No. of plots
	(a) Adjacent	(b) At random	
10 × 10	6·5	10·3	168
50 × 2	3·1	6·8	120
20 × 10	5·5	9·2	72
50 × 4	3·3	6·4	60
20 × 20	5·4	8·5	36
50 × 8	4·0	6·1	30

The long narrow plots are very distinctly more accurate than those that are square or more nearly so. In all cases the error is much less for adjacent plots than for any two at random. This difference, as might be expected, is much more marked in the case of the very narrow plots.

In a repetition series, where several strains are repeated in an orderly manner, so as to give a regular distribution of each over the whole area, the relative accuracies of different types of plot may not be the same as for comparisons of single plots.

Another point of interest also arises. In ordinary practice it is often necessary to compare together, or with a standard variety, a large number of strains. It is a matter of importance to know, for whatever system is adopted, whether the accuracy is affected by the number of strains included in one series. Is a repetition series of few strains, with the different plots of each strain comparatively near together, more accurate than one in which the plots are more scattered, through the inclusion of a large number of strains?

In order to throw some light on these points calculations of the probable error were made for arrangements representing repetition series of various numbers of strains. Thus for two strains alternate plots were taken together for the required number of repetitions, for seven strains every seventh, etc. Table V gives the results of such repetition series for several types of plot.

TABLE V.

Plot	No. of repetitions	% PROBABLE ERROR OF DIFFERENCE BETWEEN TWO			
		2 strains	7 strains	14 strains	28 strains
10 × 2	5	3·8	3·5	4·2	4·7
10 × 4	5	2·7*	3·5	3·8	4·1
10 × 10	4	3·2	3·5	3·7	...
10 × 2	10	2·6	2·5	3·1	2·8
10 × 4	10	1·9	2·5	2·4	...
10 × 2	20	1·9	1·7	2·3	...

With regard to the number of strains in one series, the results are somewhat variable but, on the whole, it appears that with a large number of strains the probable error is increased, though only to a relatively small degree. This, of course, applies only to the

special conditions of this experiment where the plots were small and each series was confined to one field.

As regards type of plot, the results indicate little material difference between plots 10 × 2, 10 × 4, and 10 × 10. What difference there is, is in favour of the broader plots. It may be noted that the figure marked with an asterisk, in the 10 × 4 results, is probably too low. In this case one field, of the three of which the combined results are given, gave a much lower figure than the other two, thus reducing the combined figure. The inference is that this figure is less reliable than the others, with which it does not agree very well, and that it would probably fall into line with them if further trials were made. The same applies to the figure for ten repetitions of the same plot and arrangement.

There is obviously no point, so far as accuracy is concerned, in reducing the width of the plot to as little as 2 plants. Anything from 4 to 10 plants wide should be satisfactory for repetition series.

A comparison of Tables IV and V shows, on the whole, very similar results. Thus single plots 50 plants in length, adjacent, give about the same results as 5 repetitions of plots 10 plants in length. There is a slight difference as regards width of plot; in the single long plots the narrowest are slightly more accurate, whereas in the repeated short plots the variation, which is less distinct, is in favour of the wider plots.

An attempt was made to employ plots 50 × 2 plants, with 9 inch spacing, in actual practice, but it was a failure as the stand was ruined by an exceptionally bad attack of crabs. It is obvious that in such small accurately spaced plots a few blanks will materially affect the results. Though a very even full stand can generally be obtained, there is always a fear that crabs may do some damage, as occasional attacks have been experienced both at Coimbatore and in Tanjore. It was therefore decided to try rather larger plots, modified so as to do away with such accurate spacing, but maintaining the long narrow shape.

A preliminary trial was made on the Manganallur Farm in Tanjore District. Three widths of plots were used, *viz.*, 5, 10, and 20 links; they were all 120 links in length. Interspaces of one link were

left between the plots, which were planted right up to the edge of the interspaces. No definite spacing was done but the inside of the plot was filled up by ordinary planting at about 6 inches apart. The results obtained from a number of plots of each width are shown in Table VI as the probable error of the difference between *any two* plots in the same field.

TABLE VI.

Plots 120 *links long.*

Plot width	% Probable error between two	No. of plots
5 links	5·8	42
10 ,, ...	5·3	26
20 ,, ...	5·7	35

There was little difference between the three widths, showing that this factor might be made very largely a matter of convenience with regard to planting, harvesting, area of land available, etc.

Further trials were made, on the Central Farm at Coimbatore, with plots $50' \times 4'$ with $1'$ interspaces. The planting was roughly $6''$ apart, giving 9 lines to each plot. The spacing was not done accurately, by measurement, but 9 lines were planted between strings placed $4'$ apart, the outside lines touching the strings. Seven fields were planted in this way, and the probable error for the difference between *any two* plots in the same field is shown in Table VII.

TABLE VII.

Plots $50' \times 4'$.

Field	No. of plots	% Probable error between two
1	16	6·4
2	13	5·1
3	11	8·6
4	11	6·8
5	13	8·2
6	14	5·8
7	12	5·5
Combined	90	6·5

The results for the separate fields are as uniform as could be expected for such small numbers of plots, and the combined figure for 90 plots, 6·5 per cent., may be taken as sufficiently accurate for such plots at Coimbatore. The combined figure for *adjacent* plots is 4·2 per cent.

Further results were obtained from actual trials of strains, carried out on the Paddy Breeding Station, in which plots 50′ × 4′ were employed. Each strain was repeated twice in a number of fields. In calculating the probable error the two plots of a strain in the same field were taken as duplicates. By working the differences as percentages it was possible to combine them into one lot and get a figure for the series as a whole. Table VIII gives the results for three such series. They agree very closely with those of Table VII.

TABLE VIII.

Plots 50′ × 4′ *in actual trials.*

Series	Pairs of duplicates	% Probable error between two
III, 17-18	29	6·2
IV Do.	49	5·9
VII, 18-19	27	6·9
Combined	105	6·6

It is desirable, where possible, to repeat each strain at least twice in every field ; a check on the results can then be exercised by calculating the probable error as above. From the point of view of accuracy of the experiment, however, this is not necessary, but each strain should be repeated the same number of times in any one field as this avoids the variation in cropping power of different fields..

The above results for 50′ × 4′ plots (Tables VII and VIII) compare very favourably with those for the small regularly spaced plots of 50 plants in length (Table IV). There are several practical advantages in favour of the former, and for the present these 4′ wide plots have been adopted on the Paddy Breeding Station at Coimbatore. This is a convenient width for one cooly to work both in planting and harvesting ; strict supervision is easy and

the work can be carried on rapidly, an important point where large numbers of strains are dealt with.

The length employed varies, according to the size of the field, from 40′–60′, the number of repetitions being adjusted accordingly and varying from about 8 to 12. The area required for each strain is about 5 cents excluding the borders of the field. Any number up to eight strains are included in one series.

The accuracy of such tests has been worked out in a number of cases. The probable error of the difference between any two plots was calculated from the figures for duplicate plots in the actual experiment, as for Table VIII. This figure was then divided by $\sqrt{n}$, n being the number of repetitions, to get the probable error of the difference between any two strains. Six out of seven results lie between 1·9 per cent. and 2·4 per cent., the seventh being 4·0 per cent. All these were on land that had been under observation for only about two or three years. On thoroughly known and selected land it should be possible to work the above system with a probable error of about 2 per cent.

THE "FRASH" (TAMARIX ARTICULATA).

BY

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In my early school-days, as we sang the "Scottish Blue-bell," I sometimes envied the "proud Indian," his "boast of jessamine bowers—the mountain, the valley with all their wild spell." The poet's picture of the rich East was too fascinating—it overshadowed the blue-bell. I have since learned that envy need not have hushed a note of the song. The jessamine blooms in the market garden under the "city wall," and mingles its heavy-sweet with the odour of the bazaar. But there are valleys in India that glow and swelter in ultra-tropical heat, yet which bloom fresh and fair during several months of the year. A large part of the Peshawar District comprises one of those favoured vales. Here, blessed by copious irrigation, the fields are more or less green always, and the landscape is graced by charming groups and lines of trees. It is in praise of one of these trees, the "ghaz" of the frontier, that I would write. Throughout the Punjab it is known as the "frash." Brandis calls it *Tamarix articulata,* and notes that it is found beyond India, in Afghanistan, Persia, Arabia, and even in North and Central Africa. Some among us who have enthusiastically hunted for herbarium specimens may have discovered an ally of the "frash" on the coast of England. My introduction to the family was by the lake at Kew. From Delhi to the Khyber, by the Grand Trunk Road, and over the yellow plains, or uprising columnar from the corn-fields, the "frash" is a familiar tree. (Plate XXVII.) On this wide area, when the district officer despairs of establishing the

UNDER THE "FRASH" IN JUNE.

shisham (*Dalbergia sissoo*), the mulberry, the poplar, the *ber* (*Zizyphus jujuba*), or even the *kikar* (*Acacia arabica*), he hopefully plants "frash," and the good tree rarely disappoints him, be the land wet or stony, deep and fertile, or even a salt-stricken plain. The cultivator in the Punjab and the North-West Frontier Province knows all about the "frash." He understands how to propagate it, and no tree is more easily raised, nor is stock of any more abundantly to hand. When it is desired to establish a boundary line between two villages, or to demarcate holdings, stout cuttings are planted *in situ* during the spring or when rain falls in August, in the confident knowledge that despite neglect, these will grow and ultimately win from the camel and the goat, the grasshopper, the village boy, or the ubiquitous white-ant.

On a fine spring morning the Peshawar valley is beautiful, fresh and sylvan. The coppiced "frash" and spreading mulberry embower the hamlet, sentinel trees stand out in the corn; the roads and the canals, the streams and water courses are traced in lines of dark pine-green, with here and there the brighter hue of tender new-clad mulberry and *shisham*. The humble cultivator is the artist who has made the landscape beautiful. He has silently, patiently, of his own free will planted "frash" to shelter his crops and cattle, to supply beams for his dwelling or fuel for the home, to provide money to marry his children.

The mulberry is the "Old Apple Tree" of the Pathan boy and girl, their leafy school of Nature-study; the tree in which they perched as they watched the ripening corn, or under whose cool shade they played and slumbered. But the "frash" is the household's friend—the "Codlin" *and* "Short" when crops fail or the cattle are afflicted, when ready-money is demanded. Most frequently the mulberry is self-sown. Like Topsy it "just growed" and the family gathered round it as its sheltering arms extended. Unlike the dwarf species of the lazy river-flat, the "frash" of the field is never a natural seedling in the North-West Frontier Province. Every tree has been planted as a cutting. Had it been necessary for the cultivator to sow seed and carefully raise seedlings, or procure these from a nursery, it is probable that the trees of the Peshawar

valley and a large part of the Punjab would at the present time be confined to the roadsides and canal banks. It is certain that wthout the "frash" the fuel supply of North-West India would be far more scanty than it is now. During the period of the war this copse-wood has proved a "mortgage-lifter" to many Peshawar cultivators ; the woodman has been busy around the villages since 1914, providing fuel for the troops on the frontier.

By the roadside on good land there are trees which are more satisfactory than the "frash." Admirable as the tree is in the field or by the village lanes, few will disagree with the writer who not long ago stated in the *Civil and Military Gazette* that the time had come when the "frash" should go from the city and cantonment. Trees that are propagated by cuttings develop a shallow root-system, and are blown down more readily than those that are raised from seeds. The "frash" is the first tree to fall before the dust-storm. Then in these days of whirling motor cars and trains of motor lorries, the roadside "frash" becomes dust-laden and unpleasing. It is no longer suitable for the roadside, it is the cultivator's tree, it is a copse-wood. Grown old, tottering and gaunt, it is picturesque but hardly a shady roadside tree. Yet the "frash" can and should be young and fresh always, for no matter how large its limbs may be, these soon break into vigorous growth when they are pruned. Even the neglected fallen trunk by the wayside mantles in tender purple and green for several years after it is laid low.

The "frash" is also useful in some minor ways. The fruit-grower has found it an excellent wind-break for his orchard. A very promising hedge which was grown from cuttings and is less than $2\frac{1}{2}$ years of age is shown in the accompanying figure. Sometimes the bark of the trees is used by the villagers in tanning, and this is another reason why the "frash" should not be planted on public highways, especially in tracts where other trees are scarce. A considerable quantity of tuberculate galls from which a dye may be prepared, is borne by the "frash," and in March and April the village girls may be seen collecting these from under the trees.

There are surely few agricultural tracts where the small farmer, unaided by the State, has made what might have been a bare country-

side one of sylvan beauty. But the cultivator of the Peshawar valley has done this, and he deserves commendation for his choice

A wind-break of "frash." It was grown from cuttings and is less than 2½ years old.

of the "frash," a copse-wood that is beautiful and useful. He has done his part in providing a continuous supply of timber that fulfils his requirements, and meets a considerable part of the local demand for fuel and light beams. In the establishment of plantations the expert sylviculturist may prefer to use rapid-growing "soft woods," but no tree that is grown from *seed* will easily displace the "frash" in the favour of the North-West Frontier Province cultivator.

NOTE ON AN OUTBREAK OF SURRA AT THE GOVERNMENT CATTLE FARM, HISSAR, AND ON CASES TREATED.

BY

R. BRANFORD, M.R.C.V.S.,

Superintendent, Government Cattle Farm, Hissar.

Surra has been the cause of such serious losses in the last few years that an account of its spread to this tract may not be without interest.

No case of the disease, so far as I am aware, had ever been diagnosed at Hissar previous to 1917.

The district, with the exception of parts of the Sirsa and Fatehabad Tahsils through which the Gugger river flows, so far as is known, has always been surra-free. No doubt surra-infected camels have occasionally been imported into the district from the neighbouring surra-infected areas of Ferozepore and Patiala, but there is no record of anything in the shape of a surra outbreak ever having occurred, and local camel-owners are not familiar with the disease.

This farm has been in charge of the Civil Veterinary Department since 1899, and has always maintained 8 to 12 riding camels, and since 1902 a considerable number of pony, mule and donkey stock. There is no record previous to 1917 of any animal ever having contracted surra.

Hence there is very little doubt that the outbreak, the subject of this note, owes its origin to the concentration of camels in Government Camel Corps at Hissar in 1917.

The 6th Government Camel Corps had its headquarters at Hissar from January to December 1917, and the 2nd Government Camel Corps from July to September 1917.

I do not think, under ordinary conditions, the posting of camel corps to Hissar, even if heavily infected with surra, would have involved much risk to susceptible animals in the neighbourhood; but on this occasion not only were the camels heavily infected with surra, but the district was also deluged with altogether abnormal rains, and consequently biting flies, capable of transmitting surra, were also abnormally numerous.

The year's rainfall amounted to 41 inches against an annual normal of 14 inches.

Approximately 11 inches of rain fell within 24 hours on 21st and 22nd August.

The 6th Government Camel Corps originally consisted of camels from Hissar District, and, except for one troop recruited from Sirsa Tahsil, was probably surra-free. Cases of surra were diagnosed in this troop early in the hot weather.

This corps left on field service in May, the surra-infected troop remaining at Hissar at the depôt. At the end of June a portion of the 2nd Government Camel Corps (4 troops) arrived at Hissar from Ferozepore. This corps since its inception had always had an exceedingly bad record as regards surra. Later other drafts of camels arrived at Hissar from other districts, including many surra-infected animals. Biting flies, including Tabanidæ, were unusually prevalent in August, September and October, and surra spread amongst the corps camels with such rapidity that by the end of October the disease had been diagnosed in almost every animal.

The camels were located on the borders of the farm, near an area habitually much grazed over by farm mares and camels. Orders were given not to graze farm animals in this vicinity, and young stock mules and donkeys, which usually go into lines in the same neighbourhood during the rains, were kept away in their winter paddocks. These orders, however, as regards grazing, were not effectually carried out. The danger area was only half a mile from the Home Farm to which all mares come at night, and on several occasions they stampeded there from other grazing grounds. Also at least on one occasion a farm camel which had strayed was caught grazing there. It is probable farm animals visited this area on

other occasions unknown to me, as it is impossible to get attendants of the class the farm is able to employ to understand the danger susceptible animals run by grazing in a surra-infected area, and if they did understand it, most of them are too careless and irresponsible to take any trouble to avoid it. The risk of infection was increased by corps camels occasionally straying and getting on to farm land.

From September on, the farm camels were kept under close observation with a view to the detection of surra, but it was not till 2nd October that the disease was definitely diagnosed in any of them. On that date No. 13 was found to be affected.

All the farm camels (8 in number) were immediately sent out to a camp in the middle of a dry grazing area some miles from any other susceptible stock, the affected animal was isolated and treated. Surra was definitely diagnosed in three more of the camels as follows :—In No. 14 on October 12th, in Nos. 9 and 12 on October 23rd.

All the camels were in fair condition. No. 13 was fat. The affected animals were all treated, details of which will be found below. The other four camels have remained surra-free up to the time of writing (February 1919).

The presence of the disease in farm camels caused acute anxiety as to other susceptible farm stock.

At that time there were present in the Home Farm 29 pony and 34 donkey mares with foals at foot, with one pony filly running with them, twenty-four pony mares without foals, 9 mule and 4 donkey foals weaned on October 15th (up to October 15th had been running with other mares and foals), 100 donkey mares and fillies, 3 Arab mares, 10 to 12 mares in foaling or hospital boxes, 7 donkey and one horse stallion in boxes. There were also 3 pony mares, 2 mule foals, and a donkey colt, in an isolation line about half a mile from the Home Farm ; the mares had been in the Home Farm till the beginning of October.

There were also 182 young stock mules and donkey colts in paddocks about half a mile from the Home Farm, and 11 pony and 25 donkey mares all heavy in foal at Chowni about 2 miles away.

The majority of the above animals were unbroken young stock.

The small veterinary staff at my disposal was very fully occupied with outbreaks of rinderpest and hæmorrhagic septicæmia among farm cattle, in addition to abnormally heavy ordinary hospital case work.

I was only able to spare one man to assist me in surra-detection work.

All the animals in the Home Farm, in the isolation hospital, had temperatures taken morning and evening daily, with the exception of the 100 donkey mares and fillies which were dealt with on alternate days.

Blood from all animals with suspicious temperatures was examined on the spot.

Surra was detected in the following animals on the following dates :—

Pony mare No. 57 on October 16th (mare had a foal at foot).

Pony mare No. 73 on October 17th (had foal at foot).

Pony mare No. 98 on October 18th (this mare was in the isolation hospital. She had a foal at foot).

Donkey mare No. 88 on October 18th (had a foal at foot).

Pony mare No. 130 on October 18th (foal had been weaned on October 15th).

Donkey mare No. 6 on October 18th (had a foal at foot).

Pony mare No. 74 on October 27th (foal had been weaned on October 15th).

These mares were all in the Home Farm and had all been grazing together up till October 15th. After detection of the first case, the whole herd was kept up and stall-fed in lines where they could get into cover in the day time to escape biting flies.

During October I was unable to pay much attention to the animals in the paddocks and at Chowni, but on November 10th mare No. 49 at Chowni was found to have surra, and mare No. 124 on the 11th. These mares had been moved to Chowni from the Home Farm on September 10th.

From November 11th, 1917, up to date (February 1919) no more cases of surra have been detected on any animal in this farm.

Of the above cases, pony mare No. 57 and donkey mare No. 6 were destroyed; the remaining animals were treated.

Before proceeding to details of treatment which will be found below, the following points seem to me to be of interest.

Period of incubation. In equine surra, I believe, this is said not to exceed 10 days. The disease was detected in pony mare No. 74 on the 27th; the last previous case among animals with which she was in contact was detected on the 18th. From the 17th onwards mare No. 74 and her companions were kept up and stall-fed and had shelter from biting flies. It is probable the mare was infected before the 17th, and as she was free of trypanosomes between 17th and 27th and the period between paroxysms does not usually exceed 10 days, it is probable that the disease was diagnosed in the first paroxysms.

Probably in natural cases the period of incubation may exceed 10 days.

Susceptibility of foals. I believe there is a superstition among camel-owners in surra tracts to the effect that young camels under their mothers are immune to surra. Leese, I believe, proved that age had no effect on the susceptibility of camels to surra, but in the light of my experience in this outbreak it seems probable that young stock do naturally escape surra more frequently than their parents. Possibly their thick woolly coats may be some protection against the biting fly.

At all events in the above outbreak no foal contracted the disease, and all the pony and donkey mares affected either had foals under them at the time the disease was detected or had them weaned from them a day or so before.

Mares Nos. 98, 73 and 88 were treated and their foals accompanied them to the isolation hospital, and so remained in contact with the disease for a long period. Biting flies too were numerous up to the end of October.

Agent of transmission. In this outbreak everything points to a "tabanus" as the agent of transmission. The common biting

flies of the district are *Stomoxys*, *Lyperosia* and *Hippoboscidæ*. Tabanidæ can generally be found near water in the hot weather and rains but as a rule is not a common fly.

In 1917, during August, September and October, Tabanidæ were numerous ; *Stomoxys* and *Lyperosia* were swarming everywhere.

At the time surra was diagnosed in pony mare No. 98 she was with two other pony mares Nos. 80 and 60, her own and another foal, and one 3-year old donkey colt. No. 60 mare is a light roan. *Stomoxys* and *Lyperosia* were so numerous that the roan mare was literally black with them in the morning and evening. Drops of blood from fly punctures on the animals could be detected at any time on any of the animals. These mares and foals remained several months with the surra cases under treatment, but none of them developed surra.

(*a*) As an item of interest, in the cases of the above blood examinations, Filaria were detected in the blood of only two, both pony mares. In one of the mares the worm was only detected on one occasion, although her blood was examined daily for two months.

(*b*) I had fully expected, if the monsoon of 1918 proved heavy, to experience another outbreak of surra, or at all events to hear of the disease in the neighbourhood, as the camel corps camels were camped in close proximity to a much frequented road, and must have infected many local camels which had to pass right through the camp to get into Hissar.

As a matter of fact monsoon rains were light, nothing was heard of surra in this district in 1918, but the disease is often so chronic in camels that it is quite probable camels infected in 1917 will be alive and be a source of danger to the district in 1919.

Details of treatments.

The following are details of treatments employed.

The large doses of antimony tartrate used intravenously were tried on the recommendation of Lieut. W. A. Poole, I.C.V.D., I.A.R.O., at the time acting as Camel Specialist. I understand large doses in camels were first tried by Mr. H. E. Cross, when that officer was Camel Specialist, with very encouraging results.

Donkey Mare No. 88 was treated by the arsenic alone method, after 3 grm. of soamin had been injected subcutaneously to drive the trypanosomes from the circulation; beginning with 0·750 grm. in bolus, the mare received 20·25 grm. of arsenic in 19 days. The arsenic was given on alternate days. The last dose was 3·25 grm. The mare weighed about 450 lb. She died of arsenic poisoning on the 24th day. There had been no return of trypanosomes to the circulation.

Pony Mare No. 74, weight 697 lb., was treated as above; beginning with 4 grm. soamin subcutaneously on October 27th, she received 38 grm. of arsenic in 23 days, the last dose being 4·75 grm. This mare was for a long time regarded as cured; by December 7th her weight had increased to 770 lb.

In April 1918 she was put on to light work; her temperature was, however, still taken night and morning, and her blood was examined weekly.

On February 21st, 1918, her morning temperature was 102·6°F. On the same evening it was down to 101·2°F. At that time her blood was being examined daily, and there was no sign of trypanosomes in the circulation.

Except for that one occasion, the mare's temperature remained normal till July 10th, when her morning temperature was 102°F. and trypanosomes were found present in the circulation. The mare was given 300 c.c. of a 1 per cent. solution of antimony tartrate intravenously. The dose proved too big and she died on July 11th, 1918.

The mare had visibly lost condition during June.

Pony Mare No. 130 was treated, to commence with, as above. The arsenic in bolus was increased from 1 to 5 grm. in 20 days, but trypanosomes appeared once during treatment, and again 3 days after the treatment was stopped. The treatment was repeated and 10 doses in 20 days were given, being increased from 4 to 7 grm. of arsenic. Trypanosomes reappeared 5 days after treatment. The mare was next treated with soamin subcutaneously, antimony tartrate intravenously, and arsenic by the mouth; 0·7 grm. of antimony tartrate was the maximum dose of that drug given. The

mare remained free of trypanosomes for 22 days. She was then treated by antimony tartrate alone, and received up to 200 c.c. of 1 per cent. solution intravenously. She remained free of trypanosomes for 41 days after the treatment ended. She was eventually poisoned in an attempt to find out the safe dose of antimony tartrate intravenously.

This mare was in poor condition when treatment began, but improved in condition all the time.

She was fat when she died. Her normal weight was about 800 lb ; shortly before her death she weighed 860 lb.

Pony Mare No. 49 was treated on the same lines as the above ; doses of arsenic in the first treatment were rapidly increased from 1 to 5 grm., but trypanosomes appeared twice during treatment and immediately after. After combined soamin, arsenic and antimony tartrate the mare only remained 13 days free. She was eventually destroyed. She was in poor condition when treatment commenced, and weighed 700 lb. on 10th November. She improved in condition, and on the 16th December weighed 824 lb., part of the increase in weight being due to the fact that she was in foal.

Shortly before she was destroyed she slipped her foal; she carried the foal to within one month of the normal gestation period.

Pony Mare No. 98, to begin with, was treated in the same way as above cases, and like them received very large doses of arsenic in bolus (up to 6·5 grm.). This mare, to start with, was in fair condition and tended to improve, but arsenic alone had little effect on the trypanosomes which appeared in the circulation during treatment. Combined soamin, arsenic and tartrate emetic (small doses) gave only slightly better results.

On February 9th treatment with antimony tartrate alone was begun. 250 c.c. of 1 per cent. solution was injected intravenously. The dose was repeated on February 12th, 15th, 18th, 21st and 24th.

Trypanosomes reappeared in the circulation on May 16th. On that date 180 c.c. of 1 per cent. solution of antimony tartrate was injected intravenously ; a larger dose had been proposed, but the injection was stopped owing to the mare exhibiting signs of distress.

On May 19th 400 c.c. of 1 per cent. solution was injected. Since that date the mare has had no rise of temperature, and trypanosomes have not been detected in the circulation. Her blood was examined almost daily up to October 31st, 1918, and two or three times weekly since.

A rabbit was inoculated with 10 c.c. of blood from this mare on November 22nd, and has remained healthy to date (February 1919).

The mare weighed 792 lb. on the 10th December, 1917, and 830 lb. on 1st May, 1918.

Pony Mare No. 73, to begin with, was treated in the same way as the above.

She received up to 6 grm. of arsenic in bolus. Trypanosomes reappeared in circulation, 12 days after conclusion of treatment.

Combined soamin, arsenic and antimony tartrate (small doses) gave no better results.

Combined prolonged treatment with soamin, arsenic and antimony tartrate, using larger doses of antimony tartrate, was begun on January 18th, and concluded on March 14th. As always in these cases, soamin was given subcutaneously, arsenic by the mouth, and antimony tartrate intravenously. Up to 200 c.c. of 1 per cent. solution of antimony tartrate was injected intravenously. The mare remained free of trypanosomes until May 25th.

On May 25th, 320 c.c. of 1 per cent. solution of antimony tartrate was injected intravenously. A larger dose was intended, but the mare's jugular glands were sore and she was fidgety under manipulation, and some of the solution got under the skin. A considerable swelling resulted, and the mare was off feed for several days. No further injections have been made to date. Trypanosomes present on the 25th May disappeared a few hours after the injection was made and have not reappeared. The mare's temperature also has remained normal. On November 22nd a rabbit was inoculated with 10 c.c. of blood from this mare. The rabbit has remained healthy.

The mare has maintained fair condition; on the 9th December, 1917, she weighed 768 lb. and on the 1st May, 1918, 860 lb.

Pony Mare No. 124 was heavy in foal when treatment began on November 11th. She remained free of trypanosomes for 20 days

after arsenic alone treatment. The maximum dose of arsenic was 5·5 grm.

The mare weighed 684 lb. on November 11th and 760 lb. on December 9th.

Combined soamin, arsenic, and antimony tartrate was begun on January 21st and continued till February 15th. The mare gave birth to a healthy full-time foal on March 18th. During March, before the mare foaled, several doses of soamin (subcutaneously) were given. The mare had plenty of milk and the foal did well, but trypanosomes reappeared in the mare's blood on April 29th.

On that date an injection of 300 c.c. of 1 per cent. solution antimony tartrate was made intravenously.

She remained free of trypanosomes till September 29th, 1918. On that date she was given 4 grm. soamin subcutaneously.

Trypanosomes disappeared and did not reappear till November 11th; 4 grm. soamin was again injected. Trypanosomes reappeared on November 21st.

5 grm. soamin was given subcutaneously. Trypanosomes have not reappeared up to date (February 1919).

The foal, now 10 months old, has done exceptionally well since birth, and is now about the finest male foal of his age on this farm.

Camel No. 9. Trypanosomes were first found in the circulation on October 24th, 1917. He was treated by combined soamin subcutaneously and arsenic intravenously, as recommended by the Camel Specialist's extant reports. The treatment concluded on Nov. 11th with 1·5 grm. arsenic intravenously and the camel off his feed. The camel fed again on the 12th, and has not been sick or sorry since up to date (February 1919). On December 10th, 1917, he weighed 1,208 lb.

His blood and temperature were examined twice weekly till December 1918, and trypanosomes have never been detected in the circulation since October 24th, 1917.

A rabbit inoculated with 10 c.c. of blood from this camel on November 27th, 1918, has remained healthy.

Camel No. 12. Trypanosomes were detected in the circulation on October 23rd, 1917. He was treated in the same way as camel

No. 9, and like camel No. 9, 15 grm. of arsenic intravenously, his last dose, put him off his feed for one day.

He has never been sick or sorry since. He was kept under observation up to December 1918. 10 c.c. of his blood was inoculated into a rabbit on November 22nd. The rabbit remains healthy.

Camel No. 14. Trypanosomes were detected in his blood on October 12th, 1917. He was treated in the same way as above and has remained healthy up to date. The rabbit inoculated with his blood on November 22nd, 1918, also remains healthy.

Camel No. 13. A Dachi. Trypanosomes were first detected on October 2nd, 1917. The arsenic and soamin treatment was not successful. Trypanosomes reappeared in the camel blood on December 9th, 45 days after the first treatment concluded.

The treatment was repeated, using small doses of antimony tartrate intravenously alternated with the arsenic doses.

Trypanosomes again reappeared 45 days after treatment concluded.

On February 14th, 1918, the camel received intravenously 250 c.c. of 1 per cent. solution of antimony tartrate. This dose was repeated on the following dates:—February 16th, 18th, 21st, 26th, March 4th, 8th, 13th and 17th.

Since February 14th, 1918, no trypanosomes have ever been detected in the blood of this camel. A rabbit inoculated on November 22nd remained healthy. The camel was kept under observation up to February 1919 and will remain under observation as opportunity permits.

All the above camels were put into regular work immediately after treatment concluded, and on some occasions worked while under treatment.

All are now in very good condition.

The Dachi No. 13 was always from the first in fat condition. She weighed 1,422 lb. on the 10th December, 1917.

All the above cases, except for one month when he was on leave, have been in the charge of Veterinary Assistant Ata Mohammed (now 2nd Farm Overseer on this farm); while he was

away they were in my sole charge. Nearly all the doses to equines were given in my presence or by me. The camels were treated (except for the one month) entirely by Veterinary Assistant Ata Mohammed, whose previous experience of the disease while serving under the Camel Specialist came in very useful.

The above results appear to me to be decidedly encouraging, while in the light of our present knowledge of surra I hesitate to claim definite cures, hasty condemnation of treatment should, I think, be deprecated.

THE IMPROVEMENT OF INDIAN DAIRY CATTLE.*

BY

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THE improvement of the milch cattle of India has occupied considerable attention in recent years, both at the hands of the departments of agriculture and of the public. It is noteworthy that, in fact, all questions connected with dairying are receiving an increasing amount of attention and study, so much so that dairy husbandry and the problems connected therewith, promise to become one of the foremost among the various branches of agricultural study in this country. We have already a fair number of large and well-equipped dairies conducted mostly by the Military Department, where milk is handled in large quantities, cream and butter made by up-to-date methods, and even the manufacture of cheese taken up. There is a goodly amount of business done by importers of dairy machinery, chiefly of cream separators and butter churns. We have a Dairy Farmers' Association in the country conducting a journal devoted to dairying matters, and an examination for the National Diploma in Dairying has been instituted which bids fair to become a coveted honour among our agricultural graduates. There is also a growing amount of recognition by Government, for some of the provincial departments of agriculture are being strengthened by the appointment of specialists in animal husbandry. Recently, too, His Excellency Lord Willingdon gave a strong impetus to the industry by himself setting an example to the landed

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* A paper read at the Sixth Indian Science Congress, Bombay, January 1919

aristocracy of India, in the matter not only of keeping high grade dairy herds on their home farms but also of building up such a herd by steady improvement.

The industry indeed is in such a backward condition and the need for improvement so great and urgent that we require all this and a great deal more of public attention bestowed on this subject. The problem of milk supply in cities is becoming every day more acute, while even in parts of the country noted for their dairy products, milk, butter and *ghee* are becoming scarce and high priced, and such as is available is often foully and shamefully adulterated. More milk and wholesome milk has to be produced at prices not so high as to make it beyond the reach of all but the well-to-do classes of people. The prices of dairy cattle and of feeds and fodders have gone up, and it seems to be admitted on all hands that the city dairyman is by no means a prosperous individual—oftentimes hopelessly in debt, and at best only making a hand-to-mouth existence.

The problem has been studied by many people, and various recommendations such as may be suited to different local conditions made. The most important among such recommendations are, firstly, the production of milk not in the cities themselves but on special farms, or as part of general farming, out in the country and the transport of the milk to the city for sale, a measure much the same as one finds in European and American cities and requiring quick transport, the organization of wholesale depôts, refrigerating arrangements, and so on. This indeed is bound to come, for it is, I venture to think, one of those changes which are brought about automatically by the growth of cities of the modern type. The second recommendation is the improvement of the milking quality of the animals themselves, *i.e.*, the breeding of a superior type of milk animal. The importance of this recommendation is too obvious to be emphasized, for the average Indian cow or buffalo seldom yields milk enough to pay for its keep.

A surer means of lifting the industry out of its present unsatisfactory condition than this one of breeding a superior type of animal cannot be thought of. When, however, we come to decide as to the method by which we have to attain this end, we are faced with

several difficulties. Shall we confine ourselves in this matter to the indigenous Indian breeds selecting the best among them, and continue the process of selection and weeding out until we get together a type considerably superior to the general bulk? There is no doubt much to be said for this method. Speaking of our own Mysore cattle, it is not uncommon to find cows yielding nearly 4,000 lb. of milk in a lactation period, and if this is a measure of the improvement possible in a general herd, it will be no small achievement if we can breed by selection alone such a type. There is again the further advantage of suitability of the breeds to their tract, for they are native to it; and, furthermore, there is the certainty of a handsome price for male calves, for these grow into a much-prized type of draft bulls. The method is however very slow, as it will take several generations of cattle to raise the level of even a picked herd. Shall we then adopt the method of crossing the local cows with English or Australian sires of reputed milking breeds? The production of animals with considerably increased milking capacity by this method is exceedingly quick, for the very first generation of the cross-bred cows shows the improvement very strikingly indeed. It is this somewhat tempting prospect of being able to collect together within a period of, say, some three to five years a herd with the high milking quality we desire so much that constitutes the merit of this method. One has only to keep a good British or Australian sire—as a matter of fact the Ayrshire seems to be the one much thought of for this country—in a herd of local cows, and wait the short period of three to five years when the offspring born of these two breeds grow and become milkers themselves.

The improvement in the milking quality of the offspring over that of their pure bred country mothers is really remarkable, as may be within the experience of all who may have compared the milk yields of such animals, so much so that it would seem indeed that the cross-bred cows would solve the problem of the milk supply in cities, at any rate, as far as the production of milk is concerned. Shall we take it then that those of us who have charge of breeding stations for dairy cattle should concentrate our efforts in this particular line of breeding in preference to grading up indigenous cattle

by selection through several years ? This I need hardly point out is a most important matter to decide, for it involves the breaking of the type of Indian cattle and the introduction into the country of a mixture of types, a measure which can certainly not be decided upon except with the fullest knowledge of the consequences. I make this the justification for my venturing to make a few observations in regard to the limitations and difficulties of this method of breeding. I do not refer to the comparatively greater susceptibility of these cross-bred cattle to the cattle epidemics of India, though that itself is a serious matter ; for it may be expected that in the cross-bred herds kept by professional dairy farmers, the necessary precautions against these epidemics, such as inoculation, segregation and so on, will be attended to promptly.

I should like to invite your attention to a different aspect of the subject, *viz.*, the risk of disappointment if certain precautions are not taken, and the production of what I may call cross-bred scrub cattle which partake of the good qualities of neither breed and perhaps combine the bad qualities of both. It is a striking fact that the cross-bred offspring of the first generation invariably possess the good milking qualities of the breed to which the foreign sire belongs. Does this justify us in inferring that the milking quality behaves as a "dominant" in the Mendelian sense ? I am aware that when we come to a character like the milking quality, which is the resultant of a number of factors in the constitution of an animal, and try to apply the principles of Mendelism to the manner of its transmission, we are treading upon thin ice. But these principles have been applied in the plant kingdom to several qualities of economic value, themselves the resultant of many factors, and I do not know if in regard to cattle, others have not sought to apply these principles to this very characteristic, *viz.*, the milking quality. If we are justified in considering this quality as a Mendelian "dominant," certain interesting conclusions follow which can guide us as to how best we can take advantage of the method on the one hand, and how we can avoid disappointment on the other.

Thus it ought to follow that (1) if we mate the pure-bred sire and one of the first generation cross-bred cows, all the offspring will

possess the dominant characteristic and will therefore be good milkers; (2) if however we mate the first generation cross-bred cow with first generation cross-bred bull, we ought to get in the progeny good milkers and bad in the proportion of 3 to 1, *i.e.*, 25 per cent. of the total must be, so far as the milking quality is considered, just as poor as the original country cow from which we started. All of them cannot be equally good by virtue of their being equal as regards the blood of the original foreign parent contained by them, but this 25 per cent. will be inferior to the remainder; (3) if again we mate a bull of the first generation cross with a country cow, that is to say, if instead of using a pure-bred foreign sire we use a first generation cross-bred bull as sire, in the herd we ought to get in the offspring good and bad milkers in the proportion of 1 to 1, that is, 50 per cent. of the total consist of poor milkers. So the proportion in this case is still further reduced. That is to say, although on account of the fact that the progeny in each case is alike as regards the degree of foreign blood in them, and breeders would say that they should consequently possess the milking or other quality in an equal measure, yet if our theory is correct, a large number cannot possess that quality. On these considerations it follows that except where we use a pure-bred foreign sire, whether it be on the pure local cow or on the first generation cross, in all other cases it will be somewhat of a toss-up as to what kind of animal we shall be getting, for, as stated above, we get both good and bad milkers. It is to this uncertainty or diminished chance of producing good animals, except where the above-mentioned precaution of using only a pure-bred sire is adopted, that I wish to invite your attention. I have come across many instances where cows evidently with foreign blood in them, as may be inferred from the suppressed hump and the broken coat colour, have proved no better than the local cows in their milking quality. Disappointments like this will increase if, as it once came under my notice, professional keepers of breeding bulls in and about the city try to meet the demand for a foreign sire by keeping only a half-bred bull instead of a pure bred, because a half-bred bull is the only one they can afford to buy.

There is then again the question of the bull-calves of this mixed progeny. In the case of pure bred local cattle, so far as Mysore is concerned, one of the chief sources of ready money to the farmer is his male calves, and with the city dairymen of Bangalore and Mysore the hope of obtaining a bull-calf from the cows is the only inducement to keep a cow which, so far as her milk yield is concerned, may be too poor to pay for her feed. The more nearly the bull-calf conforms to the popular taste in the matter of colour, physical configuration and other characters, the higher the price it fetches. This is only as I said in the case of the pure local breeds of cattle. In regard to bull-calves of cross-bred cattle, just at present at least, no buyer of draft cattle would as much as look at them. If they do find a sale, they fetch only the price of scrub cattle. The absence of the hump and the somewhat strange build of the frame and the broken colour and other features do not attract buyers. Popular belief *may be* wrong. These heavy and long bodied cross-bred bulls may be powerful animals, hardy as the local ones, and suited to the needs of the ryot. In fact a few cross-bred bullocks may be occasionally seen even in the countryside; while in cities, such bullock teams are frequently seen hauling heavy loads. It is, however, reasonable to expect that these beasts cannot be as hardy as the local breeds of bullocks, nor so capable of withstanding cattle diseases either, and in the hands of the ryot out in the villages the matter of inoculation against diseases or segregation cannot be thought of. It is, however, different with the cross-bred cows, for they are likely to be located in special dairy farms and looked after properly. It is this question then of the disposal of bull-calves, in a country where the slaughter of cattle except those which are unfit to live is considered a horrible sin, that has cooled the enthusiasm of many a dairy expert keen on the subject of cross-breeding.

Lastly is the fate of the scrub progeny of the cross-bred; we have seen that except in the cases where only the pure-bred sire is used, the offspring of cross-bred cattle cannot be all good milkers. The more we use other than pure-bred sires, the more are these uncertain cattle thrown out, both bulls and cows, the bulls possessing none of the characteristics prized by buyers of draft cattle and the

cows useless as milkers, and both being equally at a disadvantage as against pure country cattle in their susceptibility to cattle diseases. The only method of restricting the chances of such undesirable cattle is to arrange that cross-bred bull-calves are castrated at the breeding farms before the age when they can be of use as sires, just as we have been recommending for years past in the case of the undesirable male calves of the village cattle themselves.

The popularity of the cross-bred cow as a dairy animal is unquestioned and is steadily increasing. In a census I took some years ago of the dairy cattle of Bangalore this was strikingly brought out. The only reason limiting their more extended use is the loss they imply in their begetting bull-calves of practically no value. The fact that lately some among even the cross-bred cows have proved disappointing as milkers is further operating against their popularity, and I believe it is due to the indiscriminate use of cross-bred sires instead of the pure-bred ones. The fact that in their outward appearance these cross-bred bulls resemble closely their pure-bred parent, while their potency for mischief is not so apparent, is the cause of this mistake.

Probably we shall have to look to the cross-bred cow in this country more and more for the solution of the problem of the milk supply to cities, and I venture to think that the precaution of using a pure-bred bull either to meet the need of city cow-keepers or for the use of special dairy farms in the country, will minimize the risks and disappointments attendant upon the resort to this method of breeding cows for the milk trade of the country.

NOTE ON LAND DRAINAGE IN IRRIGATED TRACTS OF THE BOMBAY DECCAN.*

BY

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JUST as the conditions which determine irrigation practice in the Bombay Deccan differ in almost every essential from those which determine irrigation practice in Northern India, so the problem which confronts us with reference to land drainage differs in almost every essential.

Just as an irrigation engineer when he comes to the Deccan has to unlearn or forget a lot he hitherto looked on as the A B C of irrigation practice, so the officer in charge of drainage and reclamation can make little headway until he realizes that the problem to be faced is essentially different from what has been usually met with elsewhere.

In Northern India, I understand that—

(1) the salt pre-existed the canals;

(2) sodium carbonate gives most trouble;

(3) the soil is homogeneous; and

(4) the groundfall small.

In the Deccan—

(1) the damage may be said to be entirely due to the opening of canals;

(2) sodium carbonate is almost entirely absent, sodium sulphate and, to a less extent, chloride being in great excess;

* A paper read at the Sixth Indian Science Congress, Bombay, January 1919.

(3) the soils, subsoils and substrata vary excessively and abruptly; and

(4) the groundfall is very great (of the order of 1 in 150).

In the Deccan we are mainly concerned with six quite distinct types of surface soils and six distinct types of substrata, and these vary enormously in thickness, the change frequently being very abrupt.

From what I have said two points will be clear—

(1) that the conditions are excessively complicated; and

(2) that the problem is mainly one of preventive drainage

I do not propose to go into detail as to the difficulties met with and overcome, or the successive steps which led us to the conclusions arrived at, but will merely state broad facts.

As to whether some of the substrata are of colluvial or residual origin is still uncertain; but fortunately we can ignore this point for the moment.

Each drainage (*see* Cross Section) may be looked on as a valley once denuded of soil—and very much like any existing Deccan valley near the hills—which has been filled up with colluvial silt. There are five distinct types of strata :—

(1) Soil—impermeable when wet, but which cracks when dry.

(2) Subsoil (upper)—(i) impermeable.

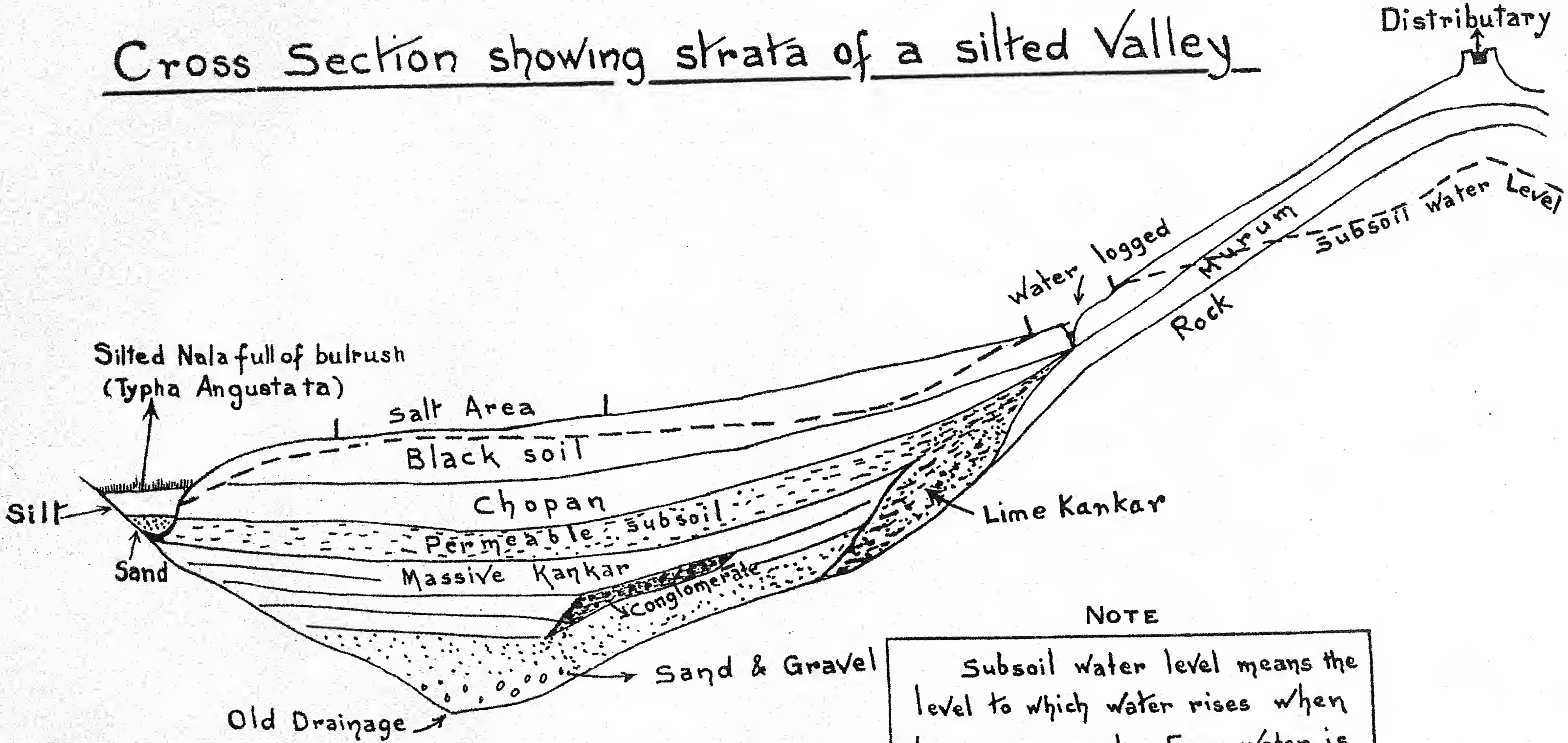
(3) Subsoil (lower)—(ii) moderately permeable.

(4) Substratum—very permeable and sometimes fissured.

(5) Fissured rock—slightly to very permeable.

Near the ridges there is a very thin layer of red soil overlying disintegrating trap rock—locally called *murum* from which it is derived. This *murum* stratum may be of considerable depth near the ridges and is excessively permeable. As we go down the sides of the ridges, we find that the surface soil gets gradually deeper both in colour and thickness, and when the *murum* becomes about 4 feet below the surface, a subsoil of yellowish red colour, locally called *chopan,* intervenes. At or near this point the permeable *murum* stratum usually dips sharply, with a consequent increase in the depth of the subsoil stratum. When this occurs we usually find

Cross Section showing strata of a silted Valley



NOTE

Subsoil water level means the level to which water rises when bores are sunk. Free water is usually not met with till the "permeable subsoil" stratum is reached.

that the subsoil is divided into an upper impermeable layer, and a lower slightly to moderately permeable layer, and the hard permeable top substratum changes to lime *kankar*, which towards the bottom of the valley changes to massive *kankar*, locally called *mân*.

We see then that we have three distinct layers of permeability, an almost impermeable upper layer of soil and subsoil, a slightly to moderately permeable subsoil, and a very permeable hard substratum, the latter very often being fissured. Bearing in mind the steep fall, it will be realized that with such strata large quantities of water will pass, through the highly permeable layer and under the impermeable surface layer, into the valleys, and will pass through into any deep river or *nala* which cuts the permeable layer. On the other hand, if the permeable layer is not cut, or if it is of insufficient thickness to get rid of the accumulated water, artesian conditions will arise, the water being imprisoned under the impermeable surface layer.

This is exactly what we find in practice in our salt areas ; and the salt is due to evaporation making a balance between water entering the subsoil, and the quantity that the natural drainage can get rid of. The amount that cannot drain away is in fact forced through the comparatively impermeable top layer until evaporation balances the excess.

As a rule, when we bore a hole in a salt area we do not find subsoil water near the surface. This is most marked. If, however, a pit is left for a couple of days, it will be found to contain water which has oozed in from the sides and bottom. This is because, as a general rule, we do not pierce the moderately permeable lower subsoil stratum till a depth of 5 to 10 feet is reached. At this level there is a sudden change, so that when the lower stratum is reached, water rushes in through the bottom of the bore hole with a hissing noise, and rises rapidly to near the surface, sometimes even pouring out at the surface. This level we call the level of " first strong flow."

When we first started this work one of our difficulties was to ascertain the permeability of soils and subsoils. Laboratory

experiments were obviously unreliable even for soils, and were quite useless for substrata. It was not until Mr. Thiselton-Dyer put me on to the 'post hole auger' which made it possible to bore holes rapidly into the subsoil, that the idea of measuring permeability by the rate of recuperation of subsoil water entered my mind. It is obviously the most perfect and simplest method to adopt, for the permeability of the stratum is measured *in situ.*

The coefficient of recuperation is measured by the formula :—

$$\frac{K}{A} = \frac{1}{T} \log \frac{H}{h}$$

where K = Coefficient.

T = Time in hours.

H = Full head of depression.

h = Head of depression after T hours.

A = Area of bore hole (which goes out in our case as it is constant).

Having obtained the level of first strong flow, and the permeability of each pit by a recuperation test, it might be thought we had only to place our drains along a line of high coefficients and at first strong flow level to effect full drainage. Unfortunately this is not the case as is exemplified in one part of the Baramati experimental area. There, a drain placed along a line of high coefficients and at first strong flow level, has had a most disappointing effect, water standing 4 feet higher than the drain at a distance of only 20 feet. Our drain has in fact merely drained off the local water, and has had practically no effect on the deep subsoil pressure which appears to be mainly developed along fissures.

This is a very extreme case, in what was the worst affected area on the whole Nira Left Bank Canal ; but many of the worst areas are modifications of this extreme type. In this area we have struck one fissure which gives a discharge of $\frac{1}{4}$ cusec, which is more than the discharge of all the drains, which total nearly a mile in length, put together.

In many cases, however, high coefficients are an excellent guide and almost always give valuable information, but they have not provided a full simple solution for all cases. In other words, it is not

always sufficient merely to trace local permeable strata ; we must also trace the natural deep subsoil flow before we can hope to make drainage fully effective at a minimum cost.

The fact that we have to deal with a pressure is what has to be grasped, and is what makes the problem so very difficult.

You cannot skim off the top water—so to speak—for the pressure still remains, transmitted through the permeable layer at a great depth and very probably through local fissures. For this reason intercepting drains have been a complete failure, the subsoil water level and pressure rising abruptly immediately below the drain. This is because we have only cut through a moderately permeable upper layer, in which the pressure is merely diffused. It is, in fact, on a parallel with trying to reduce the pressure in a water main by opening a tap in a house. Unless you can strike the main, or at least submain, you cannot appreciably affect the pressure. Another alternative would be to open hundreds of taps, *i.e.*, to open numerous small drains, but in land drainage this would be excessively costly and cannot compare with finding the main natural drainage, if that be possible.

Our first work, therefore, consists in opening out the natural deep drainages, or the original *nalas* of the denuded valley.

Recommendations have been made from time to time to reopen the existing *nalas* which have silted since the canal was opened, and where the original *nalas* and depressions were along the natural drainage lines this is what must be done. What we have found, however, is that the *nalas* very frequently do not follow the natural drainages, and that the depressions or subsidiary *nalas* seldom do. They are, in fact, nothing more than secondary superficial drainages. Besides, where they do follow the natural drainage little damage has occurred. Where the damage occurs is where the natural drainage line has been filled up with silt, and a new surface drain bearing no relation to the natural drainage has been superficially scoured.

In the canal area, many of these drainages have been opened by the irrigators along the line at which *murum* dips below the impermeable subsoil layer (*i.e.*, at the point at which the subsoil water finds an easy outlet before becoming imprisoned under the

deep *chopan* layer), while many of the partly silted natural drainages have been completely blocked by banks and levelling. Where this has been done the land is rapidly ruined, and the energy and money expended worse than wasted.

In other places the superficial trenches so far from acting as drains merely collect water, and at lower levels they act as supply channels adding to the damage instead of reducing it.

The main work to be done, therefore, is to trace the deep natural drainages, and open them out where possible. Where on account of the permeable layer being at a very great depth, as is frequently the case in the Godavari valley, all perennial irrigation must be stopped and the canal lined.

Subsidiary drainage will be comparatively simple, though costly, and this again will have to follow the natural subsidiary drainages.

Where the permeable layer is at such a depth that a drain reaching down to it is out of the question, much can still be done by driving down bore holes into this stratum, when the water rises under pressure and can be carried away by a comparatively shallow pipe drain at about 6 feet. The main difficulty about this is that the greater the depth, the greater the cost of tracing the natural drainage.

Where free drainage is prevented, and water rises to within 3 to 4 feet of the surface, damage is likely to occur. The seriousness of conditions will, therefore, be realized when it is stated that at least two-thirds of the area suitable for sugarcane in the Nira Left Bank Canal perennial section has water within this dangerous limit, and in many cases salt is merely kept down by constant heavy irrigation.

THE PREVENTION OF SOIL EROSION ON TEA ESTATES IN SOUTHERN INDIA.*

BY

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At the meeting of the Board of Agriculture in India held at Pusa in 1916, the subject of soil erosion was discussed, and it was resolved to bring to the notice of planters the fact that the serious losses due to soil erosion in the planting districts, which have taken place in the past, are to a large extent preventible.[1]

Dr. Hope, of the Indian Tea Association, has published an interesting account of the methods adopted in Java, by means of terraces, to prevent loss of valuable top soil in the tea districts.[2] Here, however, the terracing is done on new land when it is opened and before the tea is planted. The problem presented on many estates in South India is how to stop soil erosion in old established tea, and a good deal of work has been done in several districts during the last few years with the object of solving this problem in a practical and economic manner.

Two methods have been adopted with success. The first is a modification of the terracing work done in Java. At the time of pruning, trenches are opened along the contours of the slopes at intervals of four or five rows of tea bushes. These trenches are put in with a road tracer and made 18 inches to 2 feet deep, and in

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* A paper read at the Sixth Indian Science Congress, Bombay, January 1919.

[1] *Proceedings of the Board of Agriculture in India held at Pusa on 7th Feb. 1916, and following days*, p. 34.

[2] Loc. cit., p. 75.

them the tea prunings are buried, the upper layer of prunings being packed so that the butts project from the ground level when the trench is filled up some 6 or 8 inches. The soil in the intervening rows of tea is then forked and manured, if necessary, and in some cases a green dressing crop is sown on it. The fence of buried prunings serves to catch any soil which is washed down from above and retain it. Unfortunately the tea has in nearly all cases been planted in such a way that the lines run up and down the hill, and not along the contours, but it is possible to arrange for the estate work, plucking and weeding, to be done along the contours, and this gradually helps to form natural terraces where the prunings have been buried. At the next pruning season, some three or four years later in our case, the terraces are repaired and improved, and new ones made in the same way. This method has been found to stop soil erosion to a very marked extent, and it is coming much into favour on moderately steep slopes.

The second method used is to abandon forking and clean weeding on very steep slopes, and to keep the soil covered all the time by some selected weed. This method of dealing with steep slopes has of course met with a great deal of opposition from the clean weeding school; but in Southern India at any rate, I am happy to say, the fetish of clean weeding is rapidly becoming obsolete. The choice of evils lying between keeping a cover of weeds on steep slopes and allowing them to be washed by the heavy monsoon rains is largely in favour of the weeds. The utmost harm that the weeds can do is to absorb moisture in the dry weather from which the tea suffers a little, but this cannot compare with the harm done by the constant loss of valuable top soil, which goes on from slopes kept clean and forked. Any plant food which the weeds take up from the soil is ultimately returned to it again as the weeds rot down, and returned in an available form, while if the weeds are leguminous there is a steady accumulation of nitrogen.

It is sometimes thought that forking prevents soil erosion, but this is far from being the case. In the process a considerable quantity of soil rolls down the slopes on to the roads, however carefully the work may be done, and much of this is carried away by

the first heavy rains. Experiments carried out in Ceylon showed that the erosion from a forked surface was more than from a similar surface kept clean-weeded. The loss of soil from a clean-weeded surface during a certain time was 814 lb., while that from a similar surface in the same time which had received a plain deep forking was 1,393 lb.

The method adopted is to establish some particular weed by means of selective weeding—that is to say, the weeding coolies are taught to leave the particular weed chosen and remove all others by hand. In this way a cover of a particular plant is soon established on the steep slopes, and this is kept *in situ* all the time: the utmost that is done to it is to sickle it and clean it out from round the bases of the tea bushes. In this way soil erosion has been almost entirely prevented even on the steepest of banks, and in the heavy rains the run-off is clear instead of being laden with silt. Moreover, the weeds accumulate humus and add by their decomposition a valuable surface layer to the soil which is retained.

A number of weeds are being used for the purpose. The ideal plant is a leguminous one, which will accumulate nitrogen, a plant which does not either climb into the tea bushes, or make too thick a mat on the ground, and one which grows only a few inches high. Such a plant is hard to find, and the one which most nearly matches the ideal is *Cassia mimosoides*, L. This plant, at elevations of 4,000 feet and over, has a short habit of growth, branching and spreading out at the base. Its feathery semi-sensitive foliage allows the rain and sun to reach the soil, while at the same time protecting it from erosion. It is fairly easily established and it seeds freely. On many estates it forms a thick cover and has been found a most useful green dressing and soil preserver.

Another leguminous weed of which use has been made is *Parochetus communis*, Hamil., a plant with a clover-like habit, but it is not easy to establish over big areas and its life is not long; it dies down to the creeping rhizome in the hot weather

When a suitable leguminous plant cannot be found or easily established, advantage is taken of the presence of other weeds, and these are encouraged and established. Among these may be

mentioned *Oxalis corniculata*, L., which is very easily established and which forms a dense short cover easily controlled. Many hundreds of acres of steep land are now under this weed, and the tea has decidedly benefited and the soil erosion under *Oxalis* is practically nil. No harm whatever has been done to the tea; yields have been maintained and in fact have increased, and in the hot weather the effect on the tea is very slight.

Any weed has been considered better than none at all on steep slopes, and when the above-mentioned cannot be established, use has been made of the following plants, either by themselves or mixed: *Cotula australis*, Hork.; *Cardamine hirsuta*, L.; *Galinsoga parviflora*, Cav.; and *Laurenberghia hirsuta*, W. & A.

The intelligent use of weeds has gone far to overcome a form of soil erosion which has in the past caused a great loss of soil and done a lot of damage in some parts of the tea districts of Travancore. Here the land is very steep and the soil is of such a loose texture that in the dry weather the angle of repose may be exceeded, and at the least touch the top soil comes sliding down. Wind even sets it moving and the plucking coolies passing through the fields send the soil tumbling down the slopes on to the roads. The loss of surface soil in such places has been enormous and very rapid, and the ridges are in some places almost entirely denuded of surface soil.

On such soils the maintenance of a permanent crop of selected weeds has gone far to stop this loss and solve the soil erosion problem, which has always been recognized by the planters as a serious and important one.

PLATE XXVIII.

Crop of sugarcane planted with single eye-bud (point upwards).

(Group of the members of the District Agricultural Association, Dharwar, with its President Mr. E. G. Turner, I. C. S., *standing in the middle.*)

FURTHER EXPERIMENTS AND IMPROVEMENTS IN THE METHOD OF PLANTING SUGAR-CANE AND FURTHER STUDY OF THE POSITION OF SEED IN THE GROUND WHILE PLANTING.*

BY

M. L. KULKARNI,

Acting Deputy Director of Agriculture, Southern Division, Bombay Presidency.

As promised in the concluding portion of my preliminary paper,[1] read at the last meeting of this Congress held at Lahore, on the single eye-bud method of planting sugarcane with the eye-bud placed upwards, I give to-day the results of outturn as obtained by that method, and compare them with other improved methods. As stated in last year's paper, the comparative experiments were tried on the Dharwar Farm which is not quite a typical place for sugarcane. Here, owing to the peculiar conditions of soil and water, the Brix reading of the cane never went above 14 per cent. in the different methods of cultivation. Hence, in comparing the outturns, only the weight of cane is taken and not the *gur* (crude sugar).

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* A paper read at the Sixth Indian Science Congress, Bombay, January 1919.

[1] *The Agricultural Journal of India*, Special Indian Science Congress Number, 1918, p. 125.

The following is the statement of outturn of sugarcane under the two methods of planting :—

Number	Method of planting	Area in *gunthas* *	Number of eyes planted	Number of plants germinated after 20 days of planting	Percentage of germination	Number of plants finally kept, including mother and tiller plants	Number of canes harvested	Weight of cane harvested	REMARKS
								lb.	
1	Single eye-bud, point upwards.	1	901	833	82	1,079	843	4,325	
2	Three eye-buds, points sideways.	1	1,002	511	50	889	782	3,366	

* One *guntha* = $\frac{1}{40}$th of an acre.

Number	Method of planting	Number of eyes planted	Number of plants germinated	Percentage of germination	Number of plants finally kept, including mother and tiller plants	Number of canes harvested	Weight of canes harvested	Average weight of cane	REMARKS
							lb.	lb.	
1	Single eye-bud, point upwards.	27,030	24,990	82	32,370	25,290	129,750	5·1	57·8 tons.
2	Three eye-buds, points sideways.	30,060	15,330	50	26,670	23,460	100,980	4·3	

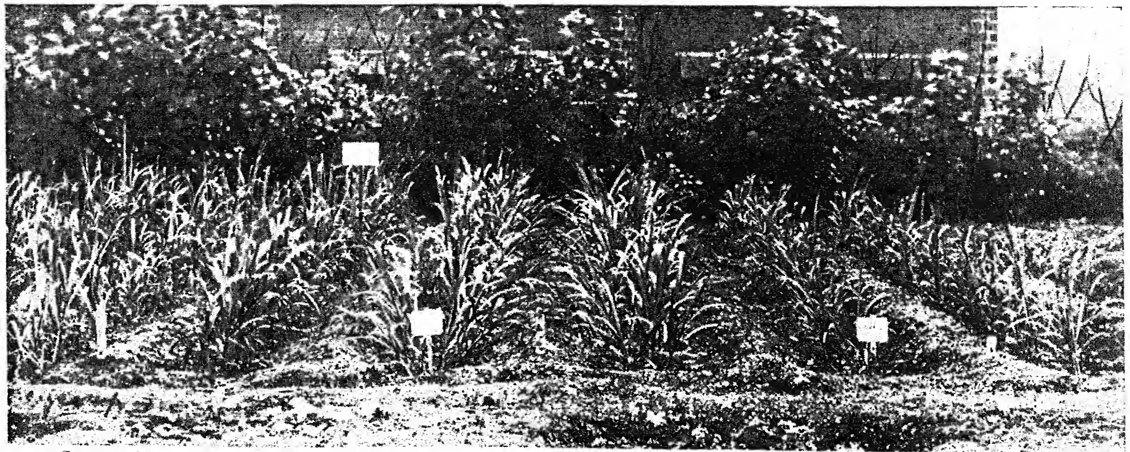
The Brix reading in both the methods, as said above, was only 14·2. With this reading, the outturn of *gur* obtained was in—

	lb.
(1) Single eye-bud, point upwards	12,570
(2) Three eye-buds, points sideways	9,660

Had the Brix been 18 or 19 per cent., as in the typical sugarcane tracts, the yield of *gur* would have been—

	lb.
(1) Single eye-bud, point upwards	16,350
(2) Three eye-buds, points sideways	12,725

PLATE XXIX.



Setts with two eyes up. Setts with three eyes side. Setts with single eye up.

Sugarcane rows during the first month.

Setts with two eyes up. Setts with three eyes side. Setts with single eye up.

Sugarcane rows after a dose of ammonium sulphate was given as a top-dressing.

Side view, in its early stage, of crop of sugarcane planted with two eyes up.
(Uniformity of crop to be marked.)

From the above statement it will be seen that, in the case of single-eye-bud planting with the point upwards, the yield of canes has been about 25 per cent. more. This higher outturn is partly due to the position of eyes while planting the setts, and partly to the removal of tillers as previously described.

Plate XXVIII is a view of last year's cane crop with single eye-bud (point upwards) at the time of harvest.

Further experiments on a larger scale are being carried out on the Canal Farm at Gokak.

There are, however, certain disadvantages in the method described above. The sett being too small and exposed on both sides close to the bud, the plants developed from these buds, though quicker in germination than the side-bud planting, look somewhat unhealthy during the first month till a small dose of ammonium sulphate is given as a top-dressing, as will be seen in Plate XXIX, fig. 1. When the top-dressing is given, the crop, though weak before, begins to grow as luxuriantly as crops under other methods. (Plate XXIX, fig. 2.)

A further improvement was made in the method of planting. Setts with three eyes were taken, as is the usual practice, and the middle eye was removed by a knife ; the sett was then placed with the remaining two eyes upwards.

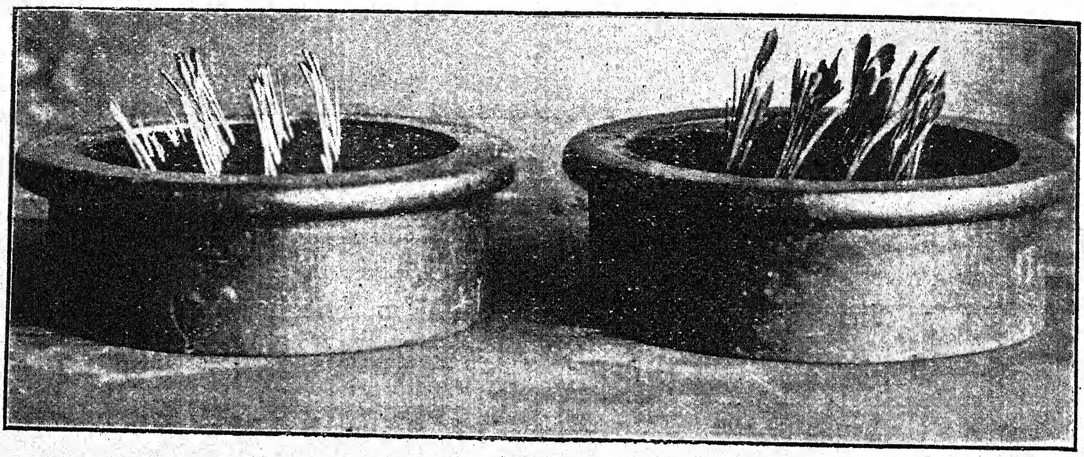
Plate XXX shows the side view of the resulting crop in its early stage.

To get the maximum number of canes in the method of "two eyes up," the setts are planted at $2\frac{1}{2}'$ to $3'$ apart, and the distance between two setts is about $6''$. This gives about 25,000 canes per acre at harvest time. It is expected that the yield of the two-eyes-up method will be better than that of the single-eye-up of last year, the former removing the defect of the small exposed sett and retaining the advantage of position of seed. The results will be available next year.

As stated in last year's paper, the uniform crop of cane obtained by the single-eye-bud method with all the eyes placed upwards suggested, with regard to the cause of unevenness in the plants in ordinarily sown field crops and the non-germination even of some

of the good seeds, that these differences may be partly due to the position in which the seeds fall in the ground while sowing. Accordingly, last year, further tests of different kinds of seeds in different positions were made.

In the case of maize, seeds planted with the points upwards germinated last, and produced weak seedlings; while seeds planted with the points downwards and sideways produced healthier plants.



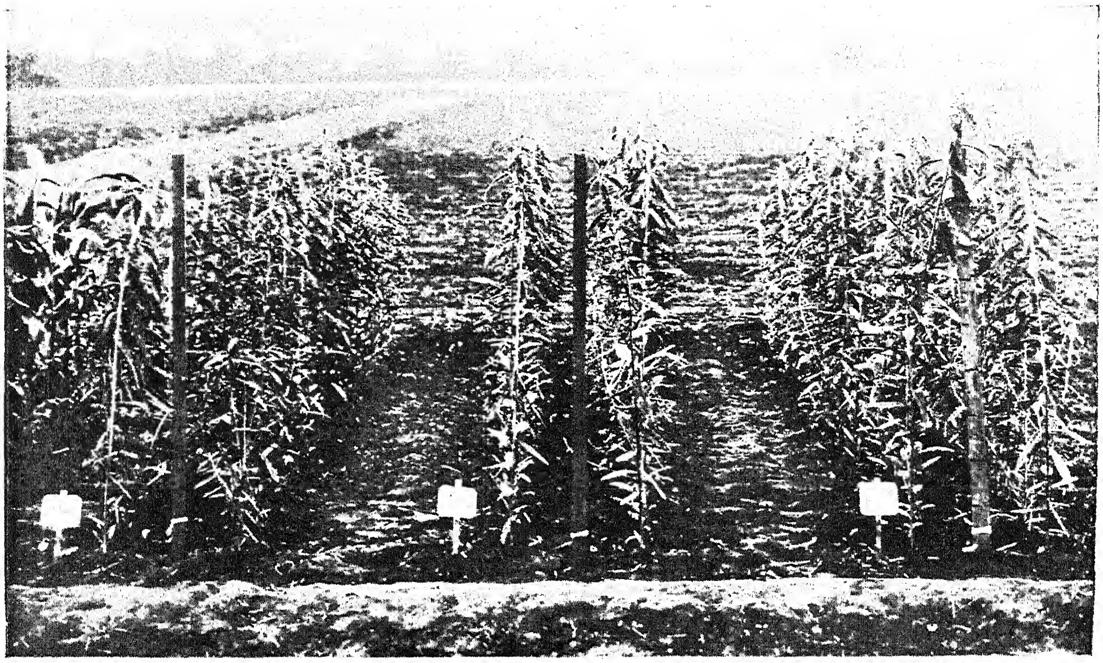
Point up-down-side-side.

Point side-side-down-up.

Pot test with maize seed.

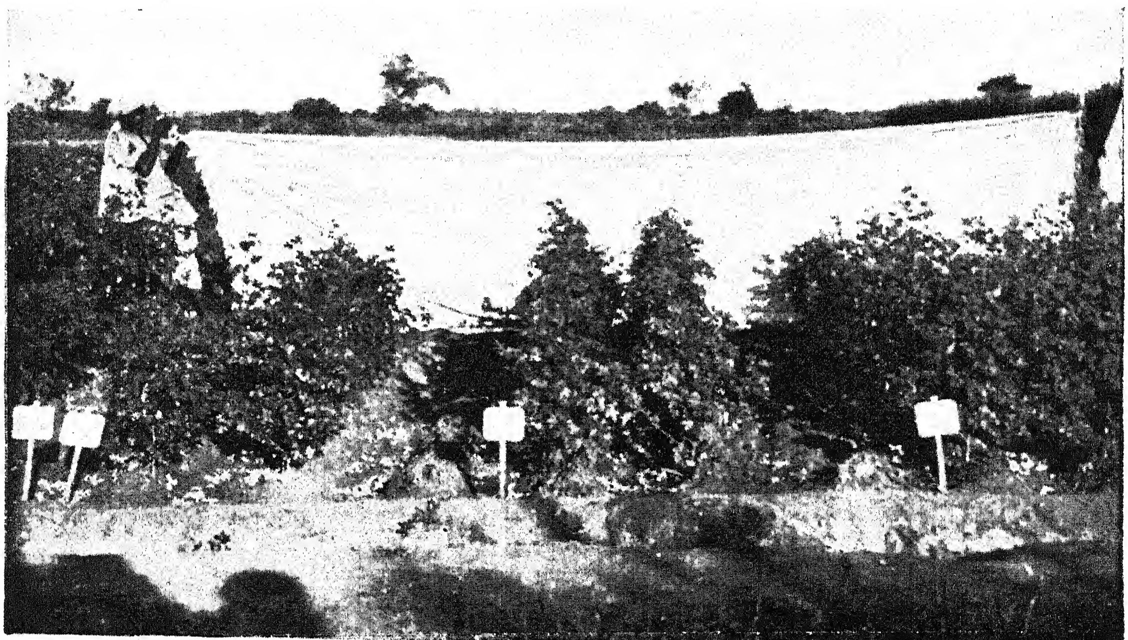
Field tests made this year on leguminous crops (*viz.*, sann-hemp, jack beans) and cotton, show that the plants produced from seeds planted with the points downwards or sideways are better than those coming from seeds with the points upwards. The results obtained in all these crops are uniform. (Plate XXXI.)

The observations made in the field experiments carried on during the current year, where seeds naturally fall deeper in the ground than in pots, showed that, as in the case of cotton described last year, the seed coat was freed in certain plants from the plumule, before appearing above ground, by the weight of the soil through which it had to force itself up. However, great variations were seen in the young plants in a field crop, some germinating early with healthy cotyledons and some coming up late with sickly seedlings though sown at the same time and under similar conditions. This induced



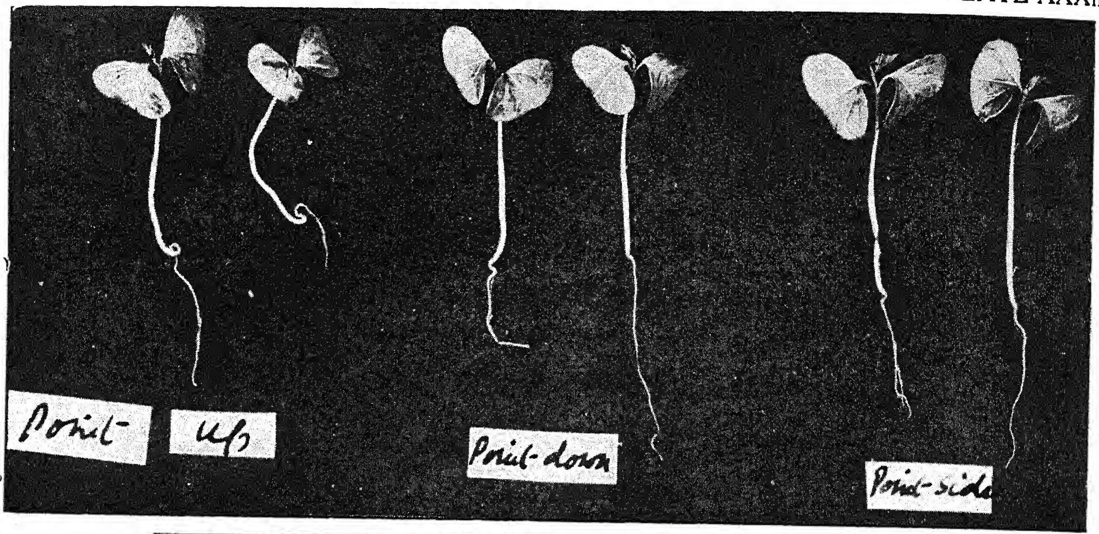
Point up. Point down. Point side.

Sann-hemp.



Point up. Point down. Point side.

Kumpta cotton, bushy type (Gokak Farm).



Radicle bent

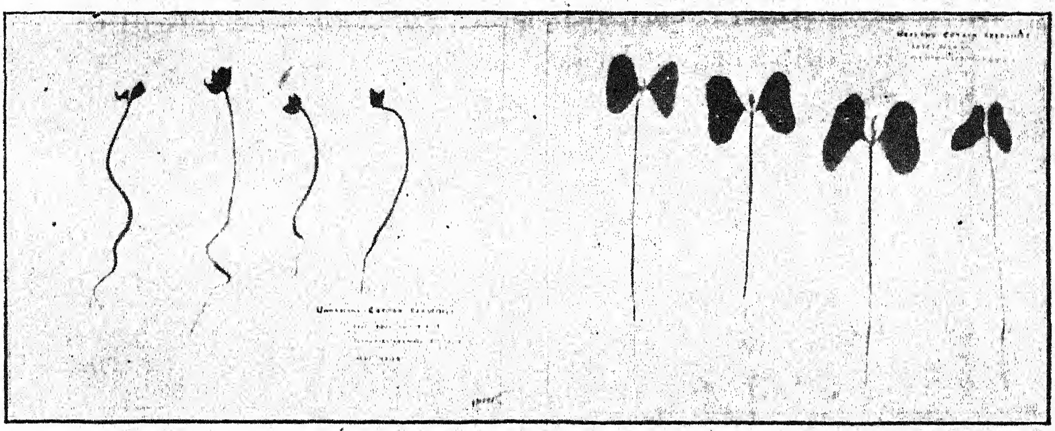
Radicle straight.

Root systems of cotton plants with different positions of seed.

the writer to examine carefully both the healthy and weak plants, and it was found that, in the case of healthy plants, the radicle and the plumule form a straight line, the former going straight down and the latter coming straight up. In the weak and late seedlings radicle and plumule go in zigzag ways.

This is partly due to the improper position of the seed in the ground, and partly due to the weight of the soil over and pressure by the side which may interfere with the seedlings. Thus the plants which receive a check in some way or other while germinating remain weak for ever, and their growth is further checked by the neighbouring plants which make a healthy start from the beginning.

The following photograph gives an idea of the root system of the healthy and weak seedlings of cotton in their early stage.



Unhealthy and healthy cotton plants from a plot ordinarily sown.

To know exactly the root system of cotton plants coming from different positions of seed, a test was made in pots, and the plants with their root systems are shown in Plate XXXII.

The root system of the seedlings, and the consequent healthy or weak appearance of the cotyledons, suggests that the unevenness of plants in crops in which seedlings are transplanted, such as chillies, brinjals, tobacco and many other vegetables and fruit trees, may be due to the improper position in which the roots are placed

in the ground while transplanting. Similarly, the unevenness in the growth of several of our cultivated fruit and other trees, and the naturally-grown timber and other forest trees, may be due to the different positions of seeds in which they are planted or fall of themselves.

Experiments on these points seem necessary.

CONCLUSIONS.

(*a*) The position of seed while sowing or planting is one among many other causes by which unevenness in plants is produced in ordinarily sown field crops, and also of the occurrence of non-germination of even some of the good seeds.

(*b*) It is possible to put the seeds in a proper position in such crops only, whose seeds or setts are dibbled or planted by hand.

(*c*) In the case of sugarcane, an absolutely uniform crop can be obtained by planting the setts with eyes upwards and by the removal of tillers.

Selected Articles

CO-OPERATIVE MARKETING.*

BY

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IN a country so predominantly agricultural as India, the most vital question is not for which crops the climate and soil are most suitable, but which crops will yield the highest net return to the cultivator. The answer to the first question is to be found in the science of modern agriculture, and different agricultural departments throughout the country are trying to discover it. The second question is a problem in practical rural economics and there is as yet no school of practical rural economics in India. When communications were ill-developed and the prime object of the cultivator was to grow food for himself and his family, and a surplus to meet their other needs, marketing was simple. The surplus was sold to the nearest buyer who paid probably the least he thought the seller would take. As communications have improved, the cultivators have become less dependent upon the local market, and it has become possible to grow tea, coffee, jute, groundnuts, and cotton for export. Where this is the case there is a tendency either towards the capitalization of agriculture, as exemplified by the big tea estates, or towards dependence upon powerful middlemen. The individual cultivator is not in a position to study the requirements of distant

* Reproduced from the *Bombay Co-operative Quarterly*, March 1919.

markets, and his own output is too small to permit of his embarking on commercial transactions. So long as he grows staple crops, he can without much difficulty secure something approaching a fair price. Wheat, for instance, being a world crop, its price is determined at the big secondary markets, of which Liverpool is the most important. Buyers in India can calculate easily the highest price they can offer so as to leave a margin of profit, and competition secures to the producer something not far removed from this. Where, however, the crop is a specialty, namely, one for which there is no regular market quotation, the producer is at the mercy of the middleman. If the specialty be not rapidly perishable, the producer may be able to hold out for a good price ; if it be perishable, such as fruit, vegetables, etc., he is practically helpless, single-handed. The production of specialties is thus dependent on the system of marketing, and it is probably defective organization for marketing that accounts, in part, for the small outturn of high paying specialties and the devotion of so large an area to less paying staple crops, such as wheat.

Speaking very generally, Indian agriculturists are poor because they are trying to maintain by extensive cultivation a population more than sufficient for the most intensive system ; as Professor Slater has pointed out, the rural worker is unemployed for a large portion of the time. In England, one man may look after a farm of 70 acres, and three would work one of 125. In this country, there would probably be from four to nine on the first, and ten or twelve on the second. In dealing with Indian problems, it is unwise to generalize, and in dealing with questions of Indian poverty it is impossible to account for all the facts by a few causes ; but there are grounds for believing that unless the excess rural population can be occupied in industries, the hope for agricultural prosperity must lie in the evolution of a highly intensive system of cultivation which will fully employ and fully repay all the labour available. If the outturn of the present kinds of crops in the Punjab were raised to the English average, it could not suffice to feed the people on the English scale. The land, in short, under the present crops will not support the people under an improved dietary. The problem of

raising the standard of food is thus not so much only of improving the outturn of existing crops, as of evolving a satisfactory system of intensive agriculture and of selecting crops that will respond to this method. Thus both producer and consumer are intimately concerned in the question of growing specialties, and as the growth of specialties is largely dependent on the system of marketing, this latter problem is deserving of wide attention and deep consideration. Now, as Mr. Keatinge has pointed out in his "Rural Economy in the Bombay Deccan," "the marketing organization is very defective and we can only look to the co-operative spirit." Where prices are indefinite, the cultivator requires an organization to protect his interests and to secure for him all the advantages his crops can earn; and whatever a cultivator requires in the way of organization the co-operative method can usually best supply.

Co-operative marketing requires more careful organization and more expert guidance than the more simple forms of co-operative activity, such as supply and credit; it calls for more discipline amongst the members and not infrequently for a considerable outlay of capital. To ensure success, careful preliminary study is required, and, accordingly, a work which describes in much detail one of the best known examples of co-operative organization for marketing is most welcome. In his "Co-operative Marketing,"[1] Mr. Cumberland has successfully attempted to draw an accurate picture of the actual operations of the series of organizations that form the distributing system of the California citrus-growers. The subject has already been dealt with in somewhat less detail in Mr. Powell's "Co-operation in Agriculture," but there is room for this more elaborate account, in view of the vast importance of creating a comprehensive system of distribution that shall be at once efficient and cheap. When the public buys food it is paying the middlemen and retailers as much to supply it as it is paying the cultivators to produce it; the consumer gets too little for his money and cannot afford to buy more, demand is thus restricted and greater supply is discouraged. There

[1] "Co-operative Marketing," by W. W. Cumberland, Ph.D., Assistant Professor of Economics, University of Minnesota.

is at present much grumbling against high prices which should be directed against high charges for distribution. The expression "high profits" is avoided, as it is doubtful if the Indian middlemen get such profits as some people think, owing to their defective methods and lack of proper organization. Somehow, the sight of an Indian middleman or retailer poring over books on marketing or studying prices in different towns and the cost of sending goods there is not common. The average member of this class could not read the books or understand the railway tariff, and his educated son becomes a pleader instead of an expert distributer. Marketing efficiency requires specialized skill, extensive information, and wide knowledge. The expert potato-grower, the owner of a fruit garden, or the industrious market-gardener around the big towns is usually profoundly ignorant of the general market situation. If he wants to know the price of a thing he will enquire from some one seeking to buy or from a friend who has just sold ; if he were told that he could get a better price at some distant town he would not know how to dispose of his crops there. He pours his produce into the nearest market which for him is not unseldom the worst. Of the advantages of warehousing, storage for a better price, preservation to last over a glut, etc., he knows but little. Of grading in order to secure a higher price for better produce he has little idea. The result is all round inferiority and waste. A cultivator is not likely to expend much effort on growing finer vegetables or better fruit, or on breeding a higher class of poultry, unless he is reasonably assured of an extra reward over and above what his less enterprising neighbour receives. In the Punjab, there was at first considerable difficulty experienced in getting a higher price for long staple American cotton. The Agricultural Department first started the auction system, and now co-operative sale societies are being formed to hold auctions. At the first co-operative sales held this season, the staff graded the cotton under the guidance of agricultural experts and the resulting classes were auctioned separately, and the prices obtained varied with the purity of the cotton. The result is that cultivators are prepared to uproot from their fields any *desi* cotton plants that have got mixed up with the American variety. Until the American type obtained a higher

price than the old short staple variety, cultivators hesitated to grow it; now the difficulty is to supply sufficient pure seed to meet the demand.

The lack of proper marketing organization may again be illustrated by reference to Punjab oranges. The province grows a fine orange known as "malta," but there is no attempt to place it on the market on a modern system. There is no grading, and hence there is no inducement to the growers to look after their trees, prune and manure them, and improve the fruit. There is little attempt to find a wider market, and hence the production is far smaller than it should be. The garden-owners usually sell the crop on the trees to a contractor and seem quite satisfied with the price. There is practically no attempt to store, though the orange being hard-skinned keeps well, and the whole produce is thrown into the towns as it ripens. What the industry might develop into, if thoroughly well organized on the lines of the California Cotton Growers Association, can only be guessed. One very important advantage to be obtained from an efficient system of co-operative marketing is the reconciliation of the two factors mentioned at the beginning of this article. For the crop for which the climate and soil are most suitable will tend to pay the cultivator the highest return if he can secure a full price of it. The adoption of business principles in agriculture will relieve the cultivator of the necessity of growing food for his family on soil that is better adapted to something else. He will be able to concentrate on the most profitable crop and to buy his food from lands better adapted to grow it. In a country of small holdings this is of great importance. The average Punjab peasant is poor on eight acres, the Californian fruit-grower is prosperous on fifteen. The former grows a variety of crops, some to eat, some to sell, some for his cattle, and some, like hemp, for the needs of his industry. He is expert in the growing of none. The expert fruit-grower can develop a high technical skill. The problems of irrigation, cultivation, fertilization, protection from pests, eradication of disease, etc., of a single crop are many, but they are less numerous than the same problems for a series of crops, so that while only the most highly trained may hope to cope with the latter, a good intelligent

cultivator should be able to acquire a sound practical knowledge of the former. High technical skill warrants the investment of considerable capital, and the cost of cultivating an acre of oranges varies from Rs. 260 to Rs. 600 a year. Obviously, with so much at stake and so much to recover, the problem of sale is of far greater importance than it is in the case of a staple crop of which the current price in the chief markets is always easily ascertainable. The price of wheat being more or less fixed by factors independent of the cultivator, the latter has to seek increased profit by increasing his production without an equal increase in cost. But in the case of a specialty the price obtained is largely dependent on the methods of marketing. If the middlemen will serve the producer honestly and well, the latter is not likely to combine, but experience shows that if the producer desires to be served honestly and well he must serve himself, in other words, he must co-operate, and if he once decides to co-operate, he will gradually gain all the advantages which large-scale efficient organization can give. Of the form of the organization that has grown up in California it is unnecessary to give details. It follows closely co-operative principles as practised elsewhere. The 'one man one vote' rule is modified to meet the circumstance that one man may have a five-acre orchard and another one of 100 acres, and votes vary with the acreage under fruit. Further, membership goes with the orchard and not with its owner. Thus a member who sells his orchard ceases to be a member. The object is to serve the growers at the actual cost of the service, and no profits are sought to be made; the "dividend malady" is thus avoided.

The actual results of the co-operative organization have been remarkable. The cost of packing has been reduced so that something approaching ten crores of rupees has been saved to the producer in twelve years; by the exercise of organized bargaining, railway rates have been reduced, resulting in a saving of fifty lakhs of rupees a year; commission on sales has been reduced from 7 or 10 per cent. to the actual cost of 3 per cent.; losses from failure to recover the sale money have been eliminated. Where the individual grower is unable to afford the time, trouble, and expense involved

in presenting a claim for damage in transit against a railway or transport company, the big organization does it for him with ease and success, and railway servants have learned in consequence to handle the goods with greater care. A further great advantage has resulted from the considerable improvement in cultural skill which the organization has encouraged. It has been possible to secure expert investigation into the various difficulties and to make the results known to the growers; great success has been attained in eliminating waste due to delay; the causes being discovered, the members have been enjoined to avoid the mistakes responsible for this source of loss. The biggest task was to find new markets to permit of enhanced production and to supply them so as to secure a good price without frightening the consumer; this was in some ways the most difficult of all, but careful study and collection of information solved it. For detailed descriptions of the methods adopted to secure these results, the reader is referred to Dr. Cumberland's book. The essential element is organization on co-operative lines, and no one acquainted with conditions in this country will be prepared to doubt that extremely valuable results await well-directed effort here. The field is immense, but comparatively speaking it is empty of workers. The commercial and trading classes show little capacity for organization. Their methods are as backward in their own business as are those of the cultivator in his. We have thousands of pleaders, but no expert market organizer, hundreds of books on Indian law, but hardly a dozen of any merit on rural economics. We are told that fathers can find no employment for their graduate sons, while numerous factors producing poverty and disease lie around neglected. To all with the leisure to read and the desire to help India, we can commend Dr. Cumberland's "Co-operative Marketing" as a study in the practical promotion of prosperity by methods open to all.

ECONOMIC CONDITIONS IN SOME DECCAN CANAL AREAS.*

BY

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THE canal areas in the Deccan have features of intense importance to co-operators in Western India as well as to all others who have an interest in the economic development of the country. Some of these, so far as I can judge, are unexpected, but the possibility of their being repeated in future similar conditions makes their study worth while at the present moment.

The greater irrigation canals of the Deccan are four, and their relative characters are as follows. I have, in each case, in order to compare the size, indicated the area of "four months' crops" which they are calculated to be able to support :—

(1) The Gokak Canal, which cost 19 lakhs of rupees, and is capable of giving water for 10,000 acres of four months' crops.

(2) The Mutha Canal, opened in 1873–78, which cost 115 lakhs of rupees, and is capable of giving water for 49,000 acres of four months' crops. (As this canal also provides the water-supply for Poona, neither the cost nor the area is comparable with the others.)

(3) The Nira Canal, opened in 1884, costing 99 lakhs of rupees, and capable of irrigating about 100,000 acres of four months' crops.

(4) The Godavari Canal, recently opened, and capable of irrigating about 57,000 acres of four months' crops.

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* Reproduced from the *Poona Agricultural College Magazine*, April 1919.

All these lie in tracts of very small and variable rainfall, most of the character of the rain coming, when it does come, in heavy storms of short duration. Except for the Gokak area, the rainfall varies from twelve inches upto about twenty-five inches per annum, but is generally under twenty inches over the much of the area. As a result of the rainfall, the hill-tops and high lands, as well as the upper portions of the slopes, are usually washed almost free of any fine soil, and hence there are on these positions very shallow stony lands. The drainage channels are deep and highly scoured. On the other hand, however, the valleys are filled with soil of good quality, whose depth largely depends on the narrowness and steepness of the valley as a whole. Previous to the advent of the canals, the wells were usually deep, and irrigation, while it existed in favoured areas, was comparatively uncommon. We have, therefore, in these areas, tracts of country, which before the construction of the canals were famine-stricken and poor, where a fairly good crop could be looked for certainly not more than one year in three, where the ordinary dry crops of the Deccan were grown, where labour was superabundant and went outside to find work, where land was cheap and manure (as in all dry-crop areas in the Deccan) little used, where the villages were small and poverty-stricken but fairly healthy, and where little capital or credit existed.

These remarks apply to all the tracts in question. In what follows, however, I am going to speak more particularly of the area covered by the Nira canal, which was not only one of the earlier canals, but was brought to a country where irrigation was a new thing, and where it has now existed long enough to enable us to judge of its economic effect. I know this valley well, and I can speak largely from my own knowledge and experience, while to co-operators it has a special interest as it has been, and is, a special field for the activity of the Bombay Central Co-operative Bank. In the year 1884, the Nira canal was opened, and the effect on the district which is covered was almost immediate. I have calculated the figures for the area under sugarcane and under gardens, and also the area carrying two crops a year in the Bhimthadi Taluka (where the greater

part of the Nira canal area is situated) at various times, and they are as follows :—

	Area under sugarcane	Area under garden crops	Area double-cropped
	Acres	Acres	Acres
1885-86	445	999	7,981
1890-91	675	2,656	14,461
1895-96	2,690	1,423	8,165
1901-02 *	5,823	2,346	19,975
1905-06	5,203	1,820	16,665
1910-11	6,229	1,246	9,626

* I have taken this year instead of 1900-01, as the latter was the year of one of the most severe famines in the Deccan, and this rather vitiates comparison with it.

The effect of the introduction of the canal on the agriculture of the area was not, in the first place, a very large increase in the amount of sugarcane, but rather an increase in the crops the people had been usually growing, like vegetables, and a larger use of double-cropping. In other words, it was a continuance of previous practice, though on a more intensive scale. But little by little it became evident that sugarcane was capable of yielding, under irrigation, greater returns than such garden crops or than such double-cropping, and very gradually the amount of sugarcane increased. This was partly due to the enterprise of the people themselves, but also, in a considerable measure, to the incoming of a group of cultivators—the Saswad *malis*—who rented the land without any idea of purchasing it, but who were expert sugarcane growers and who knew how to make large amounts of money by it.

It will be seen, however, that from a tract of intensive cultivation, the Nira valley canal area tended to become a land of one crop. Garden cultivation has declined, and the double-cropped area is now little greater than before the advent of the canal. That one crop, however, was an exceedingly valuable one and, when well cultivated, gave very large returns. Hence, the land capable of being irrigated and of growing sugarcane rose rapidly almost to ten times its former value. Areas, formerly saleable for Rs. 50 to

Rs. 100 per acre, became worth from Rs. 500 to Rs. 800, and the result was an enormous expansion of credit.

This very large increase of credit was, however, fully needed. Intensive cultivation of whatever kind leads to a very large demand for money. In the present case the demand was extreme, for, as grown in the Deccan, sugarcane needs more floating capital per acre than almost any crop that I know. A man is considered to be unwise who spends less than Rs. 500 per acre on a single year's crop. This demand for money, accompanying the rapid rise in the price of land, caused a large number of financiers or money-lenders, who usually follow closely the growth of high-class crops, to settle in the district. It will be seen that the presence of such financiers was necessary, but, as usual, when advancing money on a crop, they have charged a very high rate of interest, and bargained to act as brokers for the sale of the *gur* or *jaggery* from the cane. The usual rate of interest in the Nira valley for advances on the cane crop has been 18 per cent., the usual brokerage rate for selling the produce, I am informed, has been 8·6 per. cent.

If I may digress a little, I should like to call attention to two other indirect economic results of the bringing of canal water into the Nira canal area. The first is that it allows much greater subdivision of the ownership of the land to take place than would otherwise occur. Subdivision, to an excessive extent, is at present one of the great banes of Deccan agriculture. But subdivision in practice, if not in theory, must stop when the areas owned are not worth owning. By increasing the value of the land you can make the subdivision of ownership much greater than it was before. The second indirect result has been the creation of a feeling that actually to work on one's holding is rather beneath the dignity of a landholder, and while, before the appearance of the canal, nearly all cultivators would plough and cultivate their own land, it is now usual for almost all but the very small growers of sugarcane to carry on nearly all agricultural operations by means of labourers. There is, therefore, a greater and greater tendency to depend on labour.

These matters are, however, by the way. The general progress was as follows :—Sugarcane cultivation was found to be capable

of giving very high returns. This led to very largely increased land values, and hence to greatly expanded credit. This, again, led to the greater concentration of effort on the one crop, namely, sugarcane, which was able to give the highest returns.

Now, dependence on one crop is always a risky thing. It is risky because the variations in price of a single article (in this case, *gur* or *jaggery*) may be so great as to destroy a large part of the profit, and the crop, in this case, is on the land so long that there is little chance of a change in price being foreseen. It is also risky because a single crop is always liable to be attacked with disease or destroyed by unfavourable weather conditions, and, finally, it is risky because land is always liable to deteriorate when grown continuously or frequently to one particular crop. These risks may perhaps be faced with equanimity if a man is using his own capital, but if he is paying over 20 per cent. (including the brokerage) per annum for the capital he is employing, and if, in addition, the capital required is very great indeed, the risky nature of the cultivation is much emphasized.

In the present instance, the price has proved much more constant than might have been expected, though there was a time, about ten years ago, when it fell almost to the cost of production. The crop also has been, on the whole, very reliable, and the diseases which have ruined the crop in many other places have not done fatal damage in the Nira valley. The land has, however, in many places deteriorated badly, and this deterioration is, if my information is correct, still going on.

In an area of arid land, brought under irrigation, there is always a tendency for an accumulation of salt to take place on the surface of the land, unless drainage is particularly good. And this is particularly the case if the irrigation is intensive, and if the subsoil, formerly dry, becomes filled up with seepage from the canal or from the irrigated fields. Now, with the increase of sugarcane cultivation, the irrigation became more and more intensive, little attention was paid to drainage either by the canal authorities or by the people, the subsoil became more and more filled with water, and the land became more and more injuriously affected by salt. In many cases,

the salt increased so much tha tthe land went out of cultivation. Over five thousand acres of formerly cultivated land under the Nira valley is now useless. But, in many cases, even where the amount of salt is not sufficient to cause crops to fail, it becomes more and more difficult to obtain a first-class crop, more and more manure is required for the purpose and, hence, the already very high cost of cultivation tends constantly to increase. Closely connected with this matter, too, is another factor which has had, I believe, a very economic effect. The rise in the subsoil water has made the canal area unhealthy, and what was formerly a district very free from malaria is now one of the most malarious in the Deccan.

We have, therefore, following on the great concentration of effort, capital, and water on one crop—sugarcane—a large increase in credit, a large amount of money in circulation, a large return on capital if all went well, but a condition of things very risky for all but the most financially stable of the sugarcane growers. A year's lack of success places them in the hands of their financiers, from which they can only hope to escape by growing again the same crop. In the meantime, the expense required to get a first-class crop has been getting greater and greater, and hence the chance of a man who once made anything but a brilliant success of any particular crop getting over again into financial independence has been becoming less and less. The charges for interest and brokerage have, in fact, been so great, and the chance of the crop giving the highest yield has been getting less to such an extent, that it has been increasingly difficult for a man using other than his own capital to make his crop pay.

There has, in fact, been a tendency for the richer men in the valley who work on their own capital, still to make good profits though they acknowledge these to be much less than formerly. Many of the best of these, chiefly the Saswad *malis,* have departed to the more virgin land under the Godavari canal. Those who remain, however, still do well, tend to accumulate capital, and give an appearance of prosperity to the valley to an outsider. The much larger number, who are dependent on advances for growing their crop but who cannot cease growing it without definitely abandoning

their land to their financiers, are, I believe, not making money, but becoming poorer and poorer, and tend to be financially more involved every year.

This may be a somewhat gloomy picture of a valley, where the canal has brought so much wealth, has changed a desert into a garden, and has obtained so many advantages for the people. And I do not wish to exaggerate in the matter. Sugarcane cultivation will still give good returns with skilful and careful management. But the days when these returns could be got while paying for financial aid at the rate which has been customary are, I believe, gone. To make the industry pay in future will mean far more attention to drainage than in the past, far more care for levelling, far more trouble to get the best seed, far more skill in the selection and use of manure, and attempts (as for instance, by the use of the Manjri method of cultivation) to reduce largely the present cost of cultivation.

I expect the course of events will be more or less the same on nearly all canals, and especially on those which devote themselves to the cultivation of one particular highly profitable crop. Some men will succeed and become rich, others and the vast majority may also do well for a time until the causes I have tried to describe become operative, and they find a declining crop, which they must still cultivate, leading to hopeless financial bondage. To introduce at this stage improved credit facilities may help little, unless at the same time you bring in such agricultural improvements as will lower the cost of production, or increase the yield, or improve the quality, so that temporarily, at any rate, the return to the grower may be raised to the old rate. Then, and only then, will the improved credit facilities become really operative, and enable the cultivators who have been almost swamped, to recover their economic independence.

THE POSITION OF THE EUROPEAN SUGAR INDUSTRY AT THE END OF THE WAR.*

BY

H. C. PRINSEN GEERLIGS.

THE production of sugar in the European countries is again smaller this year than in the foregoing year, and still continues its downward course, as the table given underneath clearly shows :—

Tons of 1,000 *kilos.*

Countries of production	1913–14	1914–15	1915–16
Germany	2,718,000	2,564,000	1,600,000
Austria-Hungary	1,688,300	1,619,000	938,900
France	781,000	295,000	150,700
Russia	1,688,000	1,939,000	1,667,400
Belgium	229,000	160,000	113,100
Netherlands	231,400	295,000	242,800
Sweden	137,200	154,000	127,300
Denmark	145,700	150,000	125,000
Other countries	542,800	500,000	300,000
TOTAL ...	8,161,400	7,676,000	5,265,200

Tons of 1,000 *kilos.*

Countries of production	1916–17	1917–18	1918–19
Germany	1,500,000	1,600,000	1,400,000
Austria-Hungary	935,000	700,000	900,000
France	207,000	260,000	100,000
Russia	1,325,000	1,000,000	700,000
Belgium	135,000	150,000	100,000
Netherlands	266,000	200,000	150,000
Sweden	118,000	120,000	100,000
Denmark	114,000	200,000	115,000
Other countries	250,000	200,000	240,000
TOTAL ...	4,850,000	4,290,000	3,805,000

* Reprinted from the *Louisiana Planter and Sugar Manufacturer*, vol. LXII, no. 9.

The causes of this decline are situated only for France in the direct consequences of the war, because in that country numerous sugar houses have been wrecked or damaged or dismantled to such an extent that out of the 206 factories existing before the war, only 61 have been able to do work in this year. It is quite certain that even after the conclusion of peace a large number of the idle ones will no more be rebuilt, which is to a great extent due to the fact that the constructing shops in France have also been deprived of their machinery by the invaders.

In all the other European sugar-producing countries the indirect consequences of the war have occasioned the sharp decline in the production. In the first place, the lack of supply of foodstuffs and fodder from overseas has stimulated the agriculture of potatoes, breadstuffs, oilplants and the like to the detriment of that of sugar beets, while also the area planted with swedes, turnips and similar hoe-crops has been greatly increased, bringing along a reduction in that devoted to sugar beets.

In many instances this decrease in the area planted with beet has been made voluntarily by the growers, but in many other cases they were compelled to do so by Government regulations. Except the necessity of cultivating direct food plants, which fetch a high price and for that reason present a certain attraction, other circumstances co-operated to decrease the beet sowings still more. The beetroot requires an intensive labouring and manuring of the land and much care and weeding, in order to produce a remunerative crop, which requirements are difficult to satisfy in times of scarcity of people, horses, fertilizers and implements. Further, the beetroot is the latest crop in the year, being only ripe and saleable at a time when all other crops have already been disposed of. Finally, the beetroot wants to be pulled and hauled away within a very short space of time. As soon as the beets are ripe, they have to be carted off before the frost will retard or even prevent pulling and transportation, and if labour is short and means of transport not adequate, the crop may lose in quantity and in quality. All these reasons have induced many a farmer to restrict his beet sowings as far

as is still in agreement with the need of pulp for his cattle or the requirements of his rotation of crops.

The planted area was, therefore, much smaller than in normal times; next, the output per acre of sugar on 100 parts of beets, too, is less, thereby decreasing the sugar crop for all these three reasons. The shortage of labour and of fertilizers caused the output per acre to be less than in other years, when every care had been bestowed to the growing crop. The lack of fodder for the cattle induced the farmers to cut off large pieces of root, when removing the heads and leaves, and to keep back small beets too for cattle food, thereby reducing still more the portion of their crop coming to the sugar house. Finally, many beets were used for the manufacture of coffee substitutes and for alcohol, which together resulted in a serious shortness of material for the sugar production.

The sugar-content of the beets in the field was not a high one, as a consequence of the small amount of tillage and weeding which had been done by the deficient labourers, and further the delayed pulling and transporting caused that small sugar-content to go down still more before the roots could be worked up. The lack of coal compelled the sugar houses to work slowly and with shorter or longer interruptions, all circumstances which decreased the rudiment of sugar from the beets. Finally, the shortage of fodder brought along the necessity of producing as large a molasses output as possible, and the price of sugar in molasses was so much higher than that in the ready article, that the manufacturers left as much sugar behind in the molasses as they possibly could and thereby decreased the output of sugar on 100 parts of beet. In countries where, before the war, sugar was extracted from molasses, this process was forbidden now, also in order to leave as much molasses available for cattle food as possibly could be obtained.

Besides all these reasons, there is still a very bad factor in Russia, where since the revolution the conditions for work are so bad and so disturbed that it is not clear how matters will come to their own again. In the part of the land still belonging to the old Russia, the production of sugar has come down from 300,000 tons to a mere 70,000, while in the other parts as Ukraine and Poland

the crop appears to be about one-half of the former figure, but no reliable data are to be had and the figure in the list is only an approximate one.

On the other hand, the consumption of sugar has been greatly increased, and had to be contingented if the nations did not want to be threatened by a complete absence of that article a long time before the advent of a new crop. The armies and navies consumed much more than their individual members would have done if they had been allowed to remain in their quiet civilian occupations, and further a not inconsiderable quantity of sugar was used as a raw material in the manufacture of explosives.

The civilian population, too, extended its sugar consumption, because of the lack of butter and fat to be smeared on bread and because of a great many other articles of diet having vanished from the bill of fare. The bad, grey and unpalatable bread had to be combined with honey, jams, marmalades and the like in order to be able to be eaten with the least possible amount of disgust, and all this demanded sugar and sugar again. It soon became evident that where the home production failed, the importation from abroad was rendered impossible either by the blockade or by the U-boat warfare or by both, and where the requirements for the armies and navies had to be satisfied above all, the consumption of the civilians at home had to be greatly rationed in every European country, while the amount of sugar put at the disposal of the industries using sugar as a raw material was cut down in most places to one-fourth of that in peace times.

At the end of the great war, at the moment of the signing of the armistice and of the beginning of peace negotiations, we see in Europe a bad sugar crop just ended, with very short stocks from the foregoing crop and very very little chance of importing sugar from overseas save for England, France and Italy. A severe scarcity of sugar is to be added to the already existing shortages of fat, bread, meat, coffee, tea, spices, fodder, milk, in short, of every article of food, and no visible way of escaping famine.

Moreover, in various countries voices are heard advocating the monopoly by Government of the sugar trade, thereby levying a

high duty on sugar as a means to pay off interest and amortization of the war loans, and where a monopoly is not yet planned, a great increase of the sugar duties is contemplated, also with a view to increase the revenue of the Exchequer. The consequence of both measures will certainly be a restriction of the sugar consumption in the countries concerned.

The prospects of the European sugar industry are anything but bright, and although the armistice is concluded and perhaps peace is at last in sight, the various reasons enumerated above, which have co-operated to decrease the production, will last still a very long time and will very probably keep the European sugar production at a much lower level than it used to occupy in the happier days before the dreadful war.

INCREASED YIELDS AS THE RESULT OF SWELLING SEEDS IN WATER.

THE following note communicated by Dr. Franklin Kidd and Dr. Cyril West, of the Imperial College of Science and Technology, is reproduced from the *Journal of the Board of Agriculture*, Vol. XXV, No. 11 :—

Much interest has been aroused recently amongst agriculturists as to the possibility of obtaining increased yields from seeds which have been submitted to treatments in which soaking in water or in salt solutions plays a part. It, therefore, seems appropriate to draw attention to this subject.

Some 40 years ago two German agriculturists of repute, namely, C. Kraus[1] and E. Wollny[2], [3] showed that increased yields could be obtained by swelling seeds in water.

Their main conclusions may be summarized as follows :—

(1) In order to obtain the best results the seeds must be swollen in the minimum amount of water necessary to saturate the seeds thoroughly. (If a large excess of water is used, the effect upon the subsequent growth and yield of the plants may be harmful.)

(2) The time of immersion should be sufficiently long for the seeds to become fully swollen.

(3) A subsequent redrying of the seed does not appreciably alter the beneficial effect of the treatment, but the redrying must not be carried out too rapidly.

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[1] Kraus, C. "Untersuchungen uber innere Wachstumsursachen und deren kunstliche Beeinflussung." Wollny's *Forschungen auf dem Gebiete der Agrikultur-physik*, I—IV, 1878-1881.

[2] Wollny, E. "Untersuchungen uber die kunstliche Beeinflussung der inneren Wachstumsursachen, VII, Der Einfluss des Vorquellens des Saatgutes auf die Entwickelung und die Ertrage der Kulturpflanzen." Wollny's *Forschungen auf dem Gebiete der Agrikultur-physik*, VIII, 1885, p. 380.

[3] Wollny, E. "Saat und Pflege der landwirtschaftlichen Kulturpflanzen." Berlin, 1885.

(4) The percentage of germination is liable to be slightly decreased by the treatment.

(5) Swelling seeds in solutions of nutrient salts has much the same effect upon yield as swelling the seeds in pure water.

(6) All the seeds tested (*i.e.*, the chief cereals and various other annuals of economic importance) gave the same result, with the exception of winter rye.

As the published results obtained by these agriculturists are accessible at only one or two libraries in this country, we may profitably record here a few of their figures.

TABLE 1.—(After Wollny).

Comparison of yields from (i) seeds swollen in water and sown in the moist condition, (ii) seeds swollen and redried before sowing, and (iii) untreated seeds.

The seeds were allowed to swell in the least possible amount of water necessary for complete saturation for 36 hours (the maize for 72 hours). The redrying process extended over 14 days, during which time the seeds were left exposed to the sun and air.

Kind of seed	Date of experiment	Treatment of seed	Number of plants		Yield from 100 plants		Average weight of 100 seeds	Percentage increase or decrease in yield of seeds from experimental plants as compared with that from the controls
			Original	At the harvest	Seeds	Straw		
					grm.	grm.	grm.	
Victoria peas ...	1877	Swollen, sown moist ...	64	58	532·9*	1324*	...	+ 29
		Untreated ...	64	59	413·3*	1443*	...	......
Beans ...	1877	Swollen, sown moist ...	64	57	920·5*	2436*	...	+ 27
		Untreated ...	64	69	727·6*	2215*	...	......
Victoria peas ...	1878	Swollen, sown moist ...	100	88	1188 6	1778	...	+ 23
		Untreated ...	100	94	967·0	1658	...	......
„	1882	Swollen, redried ...	92	74	548 6	1594	...	+ 9
		Untreated ...	97	76	502·6	1684	...	......
Vetch ...	1882	Swollen, redried ...	90	79	440·4	910	...	+
		Untreated ...	96	82	417 0	1074	...	......
Winter rye ...	1882	Swollen, sown moist ...	100	96	867·0	1510	..	− 6
		Untreated ...	100	100	925·0	1690	...	......

* Yield from 64 plants.

TABLE I.—(After Wollny).—*Continued.*

Kind of seed	Date of experiment	Treatment of seed	Number of plants: Original	Number of plants: At the harvest	Yield from 100 plants: Seeds	Yield from 100 plants: Straw	Average weight of 100 seeds	Percentage increase or decrease in yield of seeds from experimental plants as compared with that from the controls
					grm.	grm.	grm.	
Victoria peas ...	1882	Swollen, sown moist ...	95	84	602·0	2012	...	+ 10
		Untreated ...	97	90	548·0	1998	...	......
Vetch ...	1882	Swollen, sown moist ...	89	87	414·0	1138	...	+ 7
		Untreated ...	98	89	388·0	1146	...	......
Victoria peas ...	1883	Swollen, sown moist ...	69	62	445·0	1355	...	+ 16
		Swollen, redried ...	79	71	511·0	1408	...	+ 34
		Untreated ...	93	83	382·0	952	...	......
Beans ...	1883	Swollen, sown moist ..	99	99	869·0	1545	46·5	+ 9
		Swollen, redried ...	100	96	868·0	1459	45·6	+ 9
		Untreated ...	99	94	798·0	1468	38·8	......
Winter rye ...	1883-4	Swollen, sown moist ...	99	60	1160·0	1983	2·99	— 8
		Swollen, redried ...	95	83	1101·0	1831	3·17	— 13
		Untreated ...	93	70	1263·0	2314	3·14	......
Summer rye ...	1884	Swollen, sown moist ...	94	80	497·0	975	2·75	+ 5
		Swollen, redried ...	85	53	559·0	1302	2·38	+ 18
		Untreated ...	89	78	475·0	1051	2·57	......
Maize ...	1884	Swollen, sown moist ...	27	27	12515·0	46740	38·9	+ 11
		Swollen, redried ...	27	26	14792·0	47577	36·1	+ 31
		Untreated ...	27	27	11274·0	41630	36·4	......
Victoria peas ...	1884	Swollen, sown moist ...	96	92	730·0	1282	27·9	+ 9
		Swollen, redried ...	92	87	705·0	1310	29·4	+ 6
		Untreated ...	94	87	668·0	1184	28·7	......
Beans ...	1884	Swollen, sown moist ...	95	77	381·0	766	47·2	+ 3
		Swollen, redried ...	95	82	402·0	792	51·0	+ 9
		Untreated ...	94	80	369·0	725	47·7	......

TABLE II.—(After Wollny).

The harmful effect of soaking seeds in excess of water.

In these experiments the volume of water used was ten times that of the seed.

Kind of seed	Treatment of the seed	Number of plants at the harvest	Yield from 100 plants: Seeds	Yield from 100 plants: Straw	Average weight of 100 seeds
			grm.	grm.	grm.
Summer rye ...	Untreated	78	475	1051	25·7
	Soaked	65	359 (—24%)	877	22·7
Peas ...	Untreated	87	668	1184	28·7
	Soaked	84	546 (—18%)	1214	27·5
Beans ...	Untreated	80	369	725	47·7
	Soaked	77	264 (—28%)	766	54·4

From a careful analysis of the growth of the plants at various stages of development, conclusions were drawn as to the reason for the increased yields obtained. The plants from the treated seeds grew more quickly in the first few weeks, came into flower earlier, flowered for a longer period, and ripened off more slowly than the plants from the untreated seeds.

Schleh[1] and Eberhart[2] have later claimed to have demonstrated that the swelling of seeds before sowing will increase the crop yield. The following table gives one set of results obtained by Eberhart in a field experiment with beans.

TABLE III.—(After Eberhart).

Comparison of yield from (i) seeds swollen in water and sown in the moist condition, (ii) seeds swollen and afterwards redried, and (iii) untreated seeds.

Harvest results.

	Number of plants*	Weight of pods	Weight of straw	Average length of the stem	Average number of pods per plant	Weight of seeds
		grm.	grm.	cm.		grm.
Untreated seeds	96·0	609·0	776·0	97·75	4·19	474·3
Seeds swollen in water previous to sowing.	96·6	697·8	877·6	103·02	5·08	543·3 (+15 %)
Seeds swollen in water and re-dried before sowing.	95·3	677·1	875·6	101·74	5·0	526·3 (+11 %)

* Mean of three experiments.

The work referred to above indicates that a definite increase in yield may be obtained by swelling the seed in water. It is clear that the water factor must be taken into account in the consideration of any process for increasing crop production which involves soaking the seed.

[1] Schleh. "Steigerung der Ernteertrage durch Impragnation des Saatgutes mit konzentrierten Losungen von Nahrsaltzen." *Fühling's Landw. Ztg.*, LVI, 1907, p. 33.

[2] Eberhart, C. "Untersuchungen uber das Vorquellen der Samen." *Fuhling's Landw. Zg.*, LVI, 1907, p. 159.

Elsewhere[1] the literature dealing with this water factor is critically reviewed, and also that dealing with the effect upon yield of the environmental conditions of the seed before harvesting, during storage, before sowing, and at the time of germination

[1] Kidd, F., and West, C. "Physiological Pre-Determination: The Influence of the Physiological Condition of the Seed upon the Course of Subsequent Growth and upon the Yield." *Review of Literature, Chapters I-IV, Annals of Applied Biology.*

THE ACTION OF MOULDS IN THE SOIL.*

The term "mould" is applied to various species of fungi isolated from the soil, which belong to widely scattered groups, and no sharp limitation is to be placed on the use of the term.

The importance of the action of moulds in the soil has been the subject of investigations by Selman A. Waksman, of the Department of Soil Bacteriology, New Jersey Agricultural Experiment Station, and he has recorded the results he obtained in a paper in *Soil Science*, August 1918. The question is of general interest to agriculturists in relation to soil fertility; a résumé of the paper is therefore given below.

When a group of micro-organisms is studied in relation to soil fertility, the question is—What part do they play in the nitrogen changes in the soil, produced as a result of their activity? From the early period of investigations on the microbial inhabitants of the soil, up to four or five years ago, the attention of soil bacteriologists was chiefly directed to the study of bacteria, neglecting other groups of micro-organisms to which the term moulds is applied. It has only been in very recent years that the great abundance of other micro-organisms, besides bacteria, in the soil has been demonstrated, and an attempt made to explain their part in soil fertility.

It has been definitely established that moulds, together with protozoa, algæ, etc., are common inhabitants of the soil, and form a large and important group of the soil flora. Hundreds of species of moulds have been isolated from the soil, and it has been found that many moulds occur in different soils under different topographic, climatic, and soil conditions. The same species has been isolated from soils in different European countries and from soils in various parts of America. New species, never met with before, have been

* Reproduced from *Agricultural News*, vol. XVIII, no. 438.

isolated from soil, serving as a proof that some of them at least are typical soil organisms.

It has also been found that moulds develop readily in acid soils, and are more active in forest and in compact poor soils, while bacteria predominate in loose soils rich in nutrient matter, cultivated and fertilized. In fact, in well cultivated lands containing relatively little humus, bacteria play a very important part, and occur in great numbers, and the moulds are of minor importance; while the upper layers of soil in forests, rich in humus as they are, contain a large number of moulds. In rainy seasons also the surface growth of moulds is greatly favoured; otherwise they live and produce spores below the surface among the vegetable residues and the living plant roots. It has been demonstrated that not only are moulds present in the soil, but that they actually live there, and produce mycelia, which necessitates their taking an active part in the different biological transformations of the soil.

Thus to be able to interpret the part played by these organisms in the soil, they must be studied as living organisms, which by their metabolic processes help in the various transformations of both organic and inorganic soil constituents, and in this way influence soil fertility.

The question of nitrogen fixation by moulds seems to be that, with the exception of some rather rare organisms, typical soil moulds do not play any direct part in the nitrogen enrichment of soils. Nor has the formation of nitrite or nitrate ever been demonstrated for any of the moulds, so that these important activities must be eliminated from the field of mould action.

On the other hand, the moulds are found to play a very important part in the disintegration of organic matter in the soil, particularly in the first stages of decay, which is termed ammonification. Whatever may be the process of formation of complex proteins by moulds, it is certain that ammonia is left in the medium as a waste product. If available carbohydrates are present, only small quantities of ammonia will be liberated by the action of bacteria and moulds; but in the absence of available carbohydrates there is a large amount of nitrogen left in the medium by their action. If the

ammonia is regarded as an indication of the amount of organic matter decomposed by a living organism, some of the moulds commonly occurring in the soil are found to possess greater powers of decomposing organic matter than are possessed by bacteria. The action of the moulds on the nitrogenous organic matter in the soil may be said to consist in the mineralization of that material with the production of ammonia and the building up of fungus proteins. The ammonia is used by the higher plants as such, or is oxidized by nitrifying bacteria into nitrates, and so used by plants, or is absorbed again by the micro-organisms of the soils.

The moulds also play an active part in the decomposition of cellulose and other carbon compounds in the soils. This is of great importance, since both green and animal manures, and all vegetable residues, need to be decomposed before the minerals and nitrogen compounds can be brought to a condition in which they can either be taken up directly by the higher plants, or in which they can undergo other transformations due to the action of other groups of moulds or bacteria. It is stated that nearly all the simple and complex organic carbon compounds in the soil can be attacked by some group or other of moulds, which thus play an important part in soil fertility. The moulds attack the carbohydrates very readily, perhaps even more readily than the bacteria, and they cause rapid decomposition of these compounds. Although more information is necessary, it appears certain now that future theories of soil fertility will have to be constructed not only from the point of view of nitrogenous manures and fertilizers and nitrogen content of the soil, but also by taking into consideration the nature and amount of carbon compounds added to it.

It must be kept in mind, however, that lower plant organisms like moulds, when present in the soil, compete with the higher plants in utilizing nitrogenous compounds for their own growth. Thus the soil moulds may produce an unfavourable effect upon soil fertility. Although this cannot be denied, two factors may be mentioned as in some degree counterbalancing the possible injury to higher plants. First, an excess of ammonium salts or nitrates in the soil tends to large losses by leaching, especially under wet climatic

conditions, the utilization, therefore, of some of these salts by the soil moulds may serve usefully for the conservation of some of this nitrogen in the soil which would otherwise be lost. Secondly, the life processes of the moulds tend to the liberation of ammonia, and to the restoring again to the soil of the nitrogen assimilated by them in an available form. Thus moulds, from this point of view, may act in the soil as storing agents for soluble nitrogen compounds; and the possible injury caused by them in competing with the higher plants for the available nitrogen may be more than compensated for by their ability to store the nitrogen and make it afterwards slowly available for the plants.

Information up to the present leads to the belief that the mould flora is more active in acid than in neutral or alkaline soil, although it does not preclude the fact that moulds are developed also in the latter type of soil. It is possible that some of the soil moulds are active in the production of acids from available carbohydrates; thus soil acidity may be due in some part not only to the production of mineral acid owing to the oxidization of minerals or added fertilizers, but also to the production by soil moulds of organic acids, such as citric and oxalic. These acids may also act upon the insoluble phosphates and other minerals in the soil, and bring them into a soluble form available for the higher plants.

One other point with regard to moulds is worth noting. Plant pathologists know that a soil may become "sick" with respect to a particular crop, due to the fact that continuous cultivation of one crop on the same soil has caused that soil to become infested with large numbers of organisms pathogenic to that particular crop. Parasitic moulds of this type have, however, been isolated from virgin soils, or from soils on which the crop they parasitized has never been grown. Further investigations are needed as to how far the soil may be considered a possible medium for nourishing moulds likely to prove dangerously parasitic.

Notes

BOARD OF AGRICULTURE IN INDIA.

THE Eleventh Meeting of the Board will be held at Pusa from the 1st to the 6th December, 1919, when the following subjects will be discussed :—

I. Programmes of work of the Imperial Department of Agriculture and of the Director and First Bacteriologist, Muktesar.

II. Programmes of work of the Provincial Agricultural and Veterinary Departments and of Native States Departments of Agriculture.

III. The necessity for investigation into the conditions of nitrogen fixation in Indian soils.

IV. Whether there is any danger of reducing the level of fertility of Indian soils by the growing of high yielding varieties of crops and the adoption of intensive methods of cultivation, without, at the same time, providing an increased supply of manurial constituents. If so, how this danger can best be met.

V. The possibility of improving (*a*) forecasts, (*b*) final statistics of areas and yields of crops in India with special reference to the recommendations in Chapter XVII of the Cotton Committee's. Report.

VI. Whether it would not be to the advantage of Indian agriculture that village *panchayats* should be empowered, where this has not already been done, to raise local rates and to initiate land acquisition proceedings for the

purpose of constructing and maintaining agricultural roads, drainage and irrigation works, and the improvement of scattered holdings, and that the necessity of creating village *panchayats* for these purposes, where they do not already exist, should be impressed upon Local Governments.

VII. Whether the Agricultural Department should not undertake the writing of books of the following types :—

(*a*) Story books idealizing agriculture and rural life generally ;

(*b*) Popular bulletins describing improved methods of agriculture ; and

(*c*) School Readers containing lessons on subjects pertaining to agriculture, in order to interest literate Indian cultivators in their life's work and to assist in the improvement of rural education.

VIII. In view of the fact that the poor acreage outturns obtained in India are to a considerable extent due to the use of inferior tillage implements, what steps, if any, should be taken to encourage the manufacture of improved implements in this country on a large scale.

IX. The importance of conserving such natural sources of manure as oilcakes, bones and fish for use in the country. What practical measures can be adopted to attain to this end ?

X. The preparation for famine conditions so far as the Agricultural Department is concerned. Can any steps be taken in advance to meet famine conditions which may occur in the future ? Can any measures be adopted to prevent good strains of crops going out of existence in famine years ?

XI. Whether any special measures are necessary with regard to the initiation or control of extensive experiments with agricultural power machinery, with special reference to motor ploughs and tractors.

XII. A complete review and discussion of the permanent experimental plots at Pusa which were laid down by a Committee of the Board of Agriculture in 1908.

XIII. Whether it is necessary to reconsider the recommendations made by the Board of Agriculture of 1916 that Government should not restrict the export of cattle that are in demand abroad.

XIV. The improvement of cotton marketing in India, with special reference to the recommendations of the Indian Cotton Committee, paragraph 233.

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WHEAT YIELDS IN THE UNITED PROVINCES.

The season which has just passed has not been a very good one for wheat. Some of it was sown late and much depended on the absence of hot west winds during the growing period. Unfortunately, there were a few days of hot wind at the beginning of March which damaged the backward crop and took several maunds off the yield. In consequence of this the outturns at the farms of the Agricultural Department have on the whole not been high and are lower than those of the past two seasons. But in some cases very high yields have been obtained even in this year, and I propose to describe the method of cultivation followed so that others who read this Journal may be induced to try it. If they do, perhaps they will themselves write and describe their experiences.

The department have been endeavouring to introduce the sowing of cane in shallow trenches, as promising the best and most certain results with improved varieties, both as regards germination and yield and sugar. Under this system, a trench two feet wide and six inches deep is dug: the earth in the trench so made is then dug with "kasis" to a further depth of nine inches and the available manure applied. Though somewhat more expensive than sowing on the flat, yet later on it saves much labour and trouble in earthing up the crop. It is essential for thick varieties which will otherwise fall down in the monsoon and the value of the cane greatly deteriorate.

It had been noted in previous years that this method of cultivating the land had a surprising effect on the succeeding wheat crop. It was more marked than usual on this year's crop. The land so cultivated had retained, except where the rains completely failed, sufficient moisture for sowing without irrigation, though in the neighbouring fields a "palewa" had often to be given before sowing. Good cultivators in these provinces are fully aware of the advantages of sowing on moisture, and make every effort to retain it even in canal-irrigated tracts.

At the Shahjahanpur farm the wheat on land which had been trenched the year before stood out above the crops of the neighbouring fields, though they too had been sown on natural moisture and on cane land which had received the same amount of manure but had not been trenched. The yields were excellent. At the Bijauria farm, Bareilly District, there was a block of wheat on six acres of such land. Up to March it was the finest wheat I had seen in India, and the Superintendent of the farm was confident that the yield would be well over 40 maunds per acre. Unfortunately part of it fell down with the heavy winds in March, and rats damaged the fallen ears. When threshed the average was just under 37 maunds. At the Shahjahanpur farm, the average yield of 3½ acres was much about the same, *viz.*, 36 maunds. This land had received no manure other than which had been applied to the previous cane crop, and was at the ordinary rate given to cane. The first of these crops was irrigated once only, that at Shahjahanpur twice. It would seem from this that quite apart from the advantages to the cane, this system of trenching will pay for itself in the next wheat crop. The cost of the operation is about Rs. 15 per acre, and considering that a good crop of improved cane will yield produce worth Rs. 350 to Rs. 450 per acre and that wheat is now selling somewhere about Rs. 5 per maund, the outlay is not excessive and the system should be worth trial in those districts where cane and wheat are commonly grown in rotation. But some strong-strawed wheat like Pusa 12 must be sown, or the heavy crop will fall with any wind or rain.—[The Hon'ble MR. H. R. C. HAILEY, in the *United Provinces War Journal*, dated 15th May, 1919.]

CERTAIN ASPECTS OF THE ORGANIZATION AND POLICY OF THE AGRICULTURAL DEPARTMENT IN BENGAL.

A Resolution, dated 7th June, 1919, issued by the Government of Bengal, says :—

As it is desirable to place the public in possession of the intentions and policy of the Agricultural Department in the agricultural development of the Bengal Presidency, the Governor in Council deems it advisable to explain in some detail certain aspects of the organization of the department, together with some suggestions derived from the experience of other countries as to how the people can best benefit from its activities.

The necessity for private effort. The two main branches of the department are the research and demonstration branches. It is, however, clear that the activities of the department in respect of the demonstration of the results of the investigations of the research branch cannot be expected to reach more than a fringe of the agricultural population without the help of the public. On the one hand, the extent of such activities is conditioned by financial considerations; on the other hand, any development of the kind is of no avail if the people are not ready or cannot arrange to take advantage of it. Individually the agriculturist is ready; experience in this country has shown that if he can see with his own eyes the value of an improvement he will adopt it. But if all are to benefit, experience in other countries shows that the agriculturists must meet Government half-way in the matter. It has been found in those countries that, if small associations of agriculturists are formed to test and adjudicate on suggested improvements, to discuss their successes and failures with each other, and to bring their needs to the notice of the Agricultural Department, then not only is the practical problem of how to reach the whole agricultural population solved, but there is hardly any limit to advancement in the direction of improved production, economic distribution, improvement of breed, and indeed in all mental and moral development. In the words of an American Professor of Political Economy, Dr. J. A. Ryan, "The transformation in the rural life of more than one European

community through co-operation has amounted to little less than a revolution. Higher standards of agricultural products and production have been set up and maintained, better methods of farming have been inculcated and enforced, and the whole social, moral and civil life of the people has been raised to a higher level. From the view-point of material gain, the chief benefits of agricultural co-operation have been the elimination of unnecessary middlemen, and the economies of buying in large quantities, and selling in the best markets, and employing the most efficient implements."

An essential condition, however, for the success of such associations is that they should be conducted on the basis of self-help. It is desirable for Government to assist such associations by teaching and exercising close control; but interference with their management or the grant of pecuniary aid by Government impairs the fundamental principle of self-reliance.

Formation of small agricultural associations in Bengal. What precise form private effort should take in Bengal, it is perhaps too early to prophesy. But undoubtedly there is every reason to believe, from the experience gained in other countries, that the formation of small agricultural associations should prove successful, whether as simple associations formed for the purpose mentioned in the preceding paragraph, or as co-operative societies dealing with the purchase of seeds and implements or with the distribution of agricultural produce. There is probably room for associations combining one or more of these functions. Apart from foreign experience and experience in other provinces in India, there is also the definite fact that such simple associations, serving thanas or even smaller areas, have met with marked success in the district of Birbhum in the Bengal Presidency. By the co-operation of official organization and private effort of this nature not only will the successes obtained by experiment be brought to fruition in the interior, but Government will be furnished with a first-hand agency for ascertaining the real needs and the wishes of the agricultural population.

His Excellency in Council hopes, therefore, to see a further extension of this experiment throughout the province, particularly

in those districts in which demonstration farms already exist or are about to be established, as it is in those districts that the Agricultural Department can give the most help. The formation of such associations rests, however, with the public ; and they will only be successful if they are financed and managed by the people. The principle accepted as essential by the Board of Agriculture in India, at their seventh meeting in 1911, was that those who are associated should all be agriculturists, really interested in local agricultural improvement.

The officers of the Departments of Agriculture and Co-operative Societies will be ready at all times with their advice and counsel.

Functions of existing associations. The extension of such small associations, if carried into effect, will inevitably involve some alteration in the functions of the existing provincial, district and divisional agricultural associations. The district associations may, for example, find, as time goes on, that their executive functions are being gradually absorbed by the working village societies. For the present, they may find that their duties are devoted to the organization of such societies. The development will of necessity be a gradual process, and the present associations will doubtless adapt themselves to changing circumstances or give way to a different organization if they cease to satisfy a real need.

The divisional associations, in particular, may not be required, while experience may show that the functions at present discharged by the provincial association can be more effectively performed by the new Board of the Agricultural Department which has been created.

Establishment of demonstration and seed farms. The research work of the department, or, more properly speaking, the investigation work, is mainly conducted at the Dacca Agricultural Station, which is the headquarters of the chemical, botanical and fibre sections, while there is a smaller investigating centre in West Bengal at Chinsura. At these centres problems of practical utility to Bengal agriculturists are investigated, such as the production of improved rice, jute and sugarcane, the suitability of various fertilizers, the

prevention of insect pests and so on; and not, as there is a tendency in some quarters to believe, research work of a purely academic interest. For the purpose of testing the results obtained at these research stations and demonstrating their value, smaller stations or farms have been established at Rajshahi and Rangpur. Private farms at Burdwan and Kalimpong are also managed by the department. The utility of these stations has been fully proved and the necessity for small farms in every district accentuated, owing to the success attained in the plant-breeding sections of the department. It has thus become necessary to arrange for the establishment of a demonstration and seed farm in each district, for the dual purpose of adjusting the results of scientific investigations at the central research stations to local conditions and of taking up the study of purely local problems. Each farm will form a centre for the demonstration of such items as have been found by actual tests to be suited to local conditions. A programme is, therefore, under contemplation for gradually providing every district in Bengal with a demonstration and seed farm as soon as practicable, whilst official sanction has already been accorded to the establishment of such farms at Mymensingh, Bogra and Comilla.

Co-operation of District Boards in establishment of farms. In view of the popular interest in agriculture, it has also been considered desirable to enlist the interest of the District Boards by requesting them to co-operate in the establishment, maintenance and management of the farms, subject to the professional control of the Agricultural Department.

In the view of His Excellency in Council the forms which the assistance from District Boards may legitimately take are as follows :—

(1) Provision of land or of money towards the acquisition of the land or towards the necessary buildings.

(2) Provision for the whole or a portion of the recurring expenditure on a farm.

The Governor in Council holds that District Boards should possess a voice in the management of the farms to the extent to which they contribute, subject to the professional control of the

department. Certain District Boards have already agreed to co-operate on these lines.

Demonstrators. For the purpose of advertising the results obtained at the central research stations and on these farms and in advising the small agricultural associations which are expected to come into being, definite circles, such as the area of a police station, are necessary for demonstration work in charge of demonstrators working under the supervision of agricultural officers. Twenty-six district agricultural officers, *i.e.*, one for each district in the presidency, have now been sanctioned; five additional agricultural officers have also been appointed for special work; and there are at present altogether 79 demonstrators. It is contemplated that, with the completion of the programme for the construction of farms and the multiplication of small agricultural associations, the number of these demonstrators will be gradually but largely increased, until there is one for each police station in Bengal.

Seed-stores. Experience in Bengal has shown that the immediate result of successful demonstration at any of the farms already in existence is a demand for improved agricultural appliances, and for seed of a new crop or of a new variety of crop. In fact, agricultural improvement in India necessitates in nearly every case the use of some new thing, whether it be seeds, fertilizers, implements or insecticides. This is exemplified by the insistent and growing demand for seed-stores in those districts where seed of a new crop variety has been issued. One seed-store will not be sufficient in a district; but seed-stores should be established also at every subdivisional headquarters and at all demonstration centres. To produce the best results such seed-stores should, however, be established and maintained by such bodies as agricultural associations or co-operative societies or local authorities. It is not, therefore, the policy of Government to establish and maintain such seed-stores themselves for areas smaller than a subdivision. Not only would this involve too large a commercial undertaking for a Government—where attempted in other countries, it has ultimately been abandoned for this reason—but it would involve too great an encroachment on the sphere of private effort. There are already

30 stores in existence under the auspices of Government, and 71 are being created under local organizations.

General policy. By the continuance of investigation for practical ends at the central farms, by the creation of demonstration farms in every district and seed-stores in every subdivision, by the appointment of a staff of agricultural officers and demonstrators in sufficient numbers to aid district officers and the department on the one hand, and the agriculturists, either individually or in association, on the other, the Bengal Government are aiming at the solution of the two problems which the Agricultural Adviser to the Government of India has declared to dominate the whole situation: the first is the provision of the best obtainable seed for any type of agricultural produce, and the second the creation of an agency for its distribution.

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THE following further extracts from official reports dealing with the use of **cactus** in the Ahmednagar District **as a fodder substitute** have been published by the Bombay Government :—

Extract from a Report No. B.—854—1918, *dated* 29*th May*, 1919, *from the Honourable Mr. L. J. Mountford, C.B.E., I.C.S., Commissioner, Central Division.*

After touring through parts of four tálukas of the Ahmednagar District and inspecting cattle camps and villages where cattle are fed on cactus, I am of opinion that the villagers have a very valuable fodder adjunct for their *kadbi* (*Sorghum* stalks) in cactus properly prepared, and consider it would be well if our expert veterinary officers could give a definite opinion on this point.

The preparation is simple. It consists in roasting the cactus over a village forge and chopping it up fine. The thorns catch fire readily, and with very little care all thorns can be destroyed. In some places women also extracted the charred tufts. This is not considered necessary, but it probably assists digestion. An admixture of strengthening food is advisable where *kadbi* is not available. In Ahmednagar, they add two pounds of cotton seed and occasionally one pound *chùni* (gram and lentil husks) to the 24 pounds full feed.

In the camps and kitchens I visited, I found cattle eating the stuff greedily. Some cattle and buffaloes will eat the prepared leaves whole, but chopped fodder is best. The people are quite enthusiastic, and, from reports received, some villages have taken to this fodder almost in a body, such as Brahmanwada (Akola) and Pedgaon (Shrigonda) and many others.

Cactus operations are not new to Ahmednagar, as they were carried out in 1912; but the village busy-body was not absent. Various rumours were started which at first somewhat impeded the campaign, such as that compulsory payment would be insisted on when the cactus campaign was closed; that the animals would die, and, when it was found that animals did not die, that they would die off in the rains. This prophecy still obtains among cactus opponents.

Villagers visit the camps and kitchens with their cattle, or ask to be allowed to take some rations away to their villages; where possible, choppers, bellows and prongs are given them. Many come to Mr. Beyts's bungalow for instruction, and while I was there, two very fine cattle in splendid condition were brought by their owner to be taught to eat cactus. I have seen cattle brought in by their owners eat their ration for the first time straightaway.

Cattle which had not the strength to raise themselves from the ground two months ago in some of the camps, are now able to do light work at the *mhote*, and to pull the cactus carts. Mr. Beyts purchased many miserable animals in the last stage of exhaustion from the butchers for a few rupees, and, after feeding them on cactus preparation, has sold them to the ryots for three times the purchase money. Mortality was very heavy before the cactus campaign started. One owner told me he lost seven of his cattle that he had fed on grass purchased for Rs. 2,000; and that he had lost none since he took to cactus. The mortality in the cactus camps has been slight.

At present there are over 34,000 cattle feeding on cactus, and it would have been utterly impossible to find grass or *kadbi* to feed these cattle. They would require at eight pounds of grass or *kadbi* a day (a low all-over daily average for cattle and young stock) some

272,000 pounds or over 80 lakhs per month. This amount of grass could not be obtained.

The present price of *kadbi* in the market varies from Rs. 40 to Rs. 60 per 1,000 pounds, while the cost of 1,000 pounds of cactus, cleaned, chopped and prepared for food is Rs. 2, to which is added Rs. 5 worth of cotton seed which is very expensive at present. *Chuni* is often added where procurable, but is not essential.

Cactus no doubt possesses a certain feeding value, but is most useful when used with cotton seed. It can also be mixed with chopped *kadbi* in the proportion of 2 to 1, and if, as is hoped, the ryots will recognize what a valuable green fodder they have all around them, the fodder resources of the country will be vastly increased, and future famines will be robbed of much of their terrors. In 1912 cattle preferred prepared cactus to the famine grass that was available that year.

I visited a charitable grass camp at Ahmednagar and elsewhere, and found the animals in no better condition than in the cactus camps. Where, as happened in both classes of camps, animals came in a very poor condition, mortality was to be expected. In one grass camp the mortality was 20 per cent. and there were many animals on the sick list, and I understand the mortality in the cactus camps did not approach this figure. I came to the conclusion that dry grass alone is not sufficient for famine cattle. In the first place, really good grass of sufficient nutriment is difficult to procure; and, secondly, some green stuff is necessary. Cattle appear to thrive better on cactus with the adjuncts employed in Ahmednagar. Again, foreign grass often disagrees with cattle. Although the local cattle in the Dángs thrive on grass, there were very heavy losses among the Ahmednagar cattle sent there, and those that returned came back in a miserable condition.

Extract from a Report No. 1996, *dated* 11*th June*, 1919, *from Lieutenant-Colonel G. K. Walker, C.I.E., O.B.E., F.R.C.V.S., Superintendent, Civil Veterinary Department, Bombay Presidency.*

I have visited cattle camps in the Ahmednagar and Poona Districts where cattle are being fed on prickly pear, and recently

(May 11th to 15th) I made a detailed inspection in the Ahmednagar District in this connection. I paid surprise visits to a number of villages in various directions where the fodder was being used, and visited the camps at Ráhuri, Shrigonda and Wakodi. I also visited the charitable camp at Ahmednagar where the cattle were being fed on dried grass and *kadbi*, no prickly pear being used.

I can bear out the Hon. Mr. Mountford's statements in every particular. There can be no doubt that cattle can be maintained on prickly pear when necessary without harm. It is not claimed that it ranks as a good fodder, and it should be supplemented with a certain amount of dried grass if possible in addition to some proportion of concentrate. Cattle require a proportion of green fodder to keep in good health, and the dried grass that passes as hay in this country is frequently so inferior and innutritious that it causes internal disorders, especially in debilitated cattle. Animals have their idiosyncrasies, and there may be cases where prickly pear causes indigestion, especially if it is improperly prepared. It is essential that all the prickles should be removed. Like all green fodders it produces some looseness of the bowels, which is considered normal to cattle in countries where green fodder is common. Any excessive looseness can be remedied usually by supplying fodder in intelligent proportions. Diarrhœa in cattle in the rains is common from various causes. I have written a leaflet on the subject, which is being published by the Agricultural Department in English and three vernaculars.

I beg to say that in my opinion the cactus fodder campaign, particularly in the Ahmednagar District, has been a great success, and that by the aid of this fodder a very large number of cattle that would otherwise have died have been saved. The work in the Poona District has also been effectual. A very pleasing feature in the Ahmednagar District is the obvious satisfaction of the cattle-owners when once they have been persuaded to take up the method. They have learned to appreciate its advantages, and in many places their own arrangements are well devised and working well.

In the *Rhodesia Agricultural Journal*, December 1918, there is some advice as to plants suitable for forming **cattle-proof hedges** on Rhodesia. Among these is Bougainvillæa, especially the two species *glabra* and *spectabilis*. This is used as an ornamental hedge in some of the West Indian islands, and is certainly of a strong enough growth to form a close hedge of any height or width which may be desired. The blaze of colour in the flowering season, which is almost the whole year, makes it a most showy object. The two species of Bougainvillæa mentioned above grow easily from cuttings inserted in the ground. Until growth starts, they should be kept well supplied with water. The plants are extremely hardy, and, when established, will stand long periods of drought.

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The Rothamsted Experimental Station has been engaged for some time in field trials and other investigations to discover what value **ammonium nitrate** possessed **as a fertilizer.** Dr. E. J. Russell thus summarizes the general results of the experiments in the *Journal of the Board of Agriculture*, Vol. XXV, No. 11 :—

(1) Ammonium nitrate is an excellent fertilizer, the nitrogen of which is worth as much as that in nitrate of soda and sulphate of ammonia. At present prices of these two fertilizers, ammonium nitrate would, on the same basis, be worth £37 5*s*. per ton.

(2) It contains more than twice as much nitrogen as nitrate of soda, and one and three-quarters times as much as sulphate of ammonia : it is thus the most concentrated nitrogen fertilizer obtainable on the large scale. Where 1 cwt. of nitrate of soda or $\frac{3}{4}$ cwt. of sulphate of ammonia is ordinarily used, less than $\frac{1}{2}$ cwt. of nitrate of ammonia would be required.

(3) It can be applied to any crop for which nitrate of soda is suitable, but it is not superior to sulphate of ammonia for potatoes, and may be inferior. Its proper use is as a top-dressing, and not as a constituent in mixed manures.

(4) Farmers must insist on having the "non-deliquescent" variety, otherwise they will certainly be inviting trouble.

(5) While the material itself is not inflammable, it yet helps a fire considerably. Great care is, therefore, necessary not to store under conditions where a fire might be started.

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THE COCOA PRODUCTION OF THE EMPIRE.

Among the products of the Empire which before the war were not utilized in the United Kingdom to the extent they might have been, cocoa takes a prominent place. The quantity of cocoa produced in British countries in 1913 was more than three times the amount consumed in the United Kingdom, yet that country only obtained about one-half its supplies from those sources, the remainder consisting largely of South American cocoa and foreign cocoa shipped *viâ* continental countries. Not only was this the case, but the British Isles were importing large quantities of prepared cocoa and chocolate from foreign countries which had been manufactured there from British grown cocoa. During the war the position improved and a much larger proportion of the raw cocoa came from the Empire, no less than 86 per cent. of the total imports coming from British possessions in 1917, and it is to be hoped that this state of affairs will continue. The importance of the matter will be realized when it is stated that in 1916 the total imports were valued at no less than six and three quarter million pounds sterling. The question of the production of cocoa in the different countries of the Empire, the world's consumption, and the cocoa trade of the United Kingdom is fully discussed in an article in the January–March (1919) Number of the "Bulletin of the Imperial Institute." Of the many interesting points brought out, two call for special mention. The first is the unprecedented growth of the cocoa industry in the Gold Coast, where the product is grown and prepared for the market entirely by the natives. The colony commenced to export cocoa in 1891 and it now produces more than one-quarter of the world's output. The other equally remarkable fact is the enormous increase in the consumption of cocoa in the United States in recent years. The consumption has trebled since 1913 and about one-half the total quantity produced in the world now goes to the States.

The cocoa industry of the Gold Coast is also dealt with at length in a message addressed to the Legislative Council of the Colony by Sir Hugh Clifford, the Governor, which appears in the same Number of the Bulletin.

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

WOODHOUSE-SOUTHERN MEMORIAL FUND.

				Rs.
DONATIONS received up to the 31st May, 1919, and acknowledged in the *Agricultural Journal of India*, Vol. XIV, Pt. IV, July 1919				1,930
Donations received during the period from 1st June to 31st August, 1919 :—				
V. G. Gokhale, Esq.	..	..	..	10
S. K. Basu, Esq. ..	..	..	..	10
	TOTAL	..		Rs. 1,950

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THE names of the undermentioned have been brought to the notice of the Government of India for valuable services rendered in India in connection with the war up to 31st December, 1918 :—

The Hon'ble Mr. H. R. C. Hailey, C.I.E., I.C.S., Director of Land Records and Agriculture, United Provinces.

Mr. B. C. Burt, M.B.E., B.Sc., Deputy Director of Agriculture, Cawnpore.

Colonel J. Farmer, C.I.E., F.R.C.V.S., Chief Superintendent, Civil Veterinary Department, Punjab.

Colonel H. T. Pease, C.I.E., M.R.C.V.S., Principal, Veterinary College, Punjab.

Mr. J. G. Cattell, M.R.C.V.S., Superintendent, Civil Veterinary Department, Sind, Baluchistan and Rajputana.

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LIEUT. (TEMP. COL.) GEOFFERY EVANS has been appointed an additional Companion of the Most Eminent Order of the Indian Empire in connection with the military operations in Mesopotamia.

Mr. P. P. M. C. Plowden, I.C.S., Joint Magistrate, Agra, has been appointed Under Secretary to the Government of India, Revenue and Agriculture Department.

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Mr. W. A. Davis, B.Sc., A.C.G.I., has been granted special privilege leave for five months with effect from the 11th October, 1919.

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Mr. G. S. Henderson, N.D.A., N.D.D., Imperial Agriculturist, has, on the termination of his deputation under the Munitions Board, been granted with effect from 23rd June, 1919, combined leave for six months, *viz.*, privilege leave for 3 months and 10 days and study leave for the remaining period.

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Mr. J. H. Walton, B.A., B.Sc., Supernumerary Agricultural Bacteriologist, Pusa, has been granted combined leave for six months.

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The services of Mr. M. Afzal Husain, B.A., Supernumerary Entomologist, Pusa, have been placed at the disposal of the Government of the Punjab.

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Mr. J. F. Dastur, M.Sc., who has been appointed to the Indian Agricultural Service, is appointed Supernumerary Mycologist at Pusa, with effect from the 30th June, 1919, and deputed to England for fifteen months for training.

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Mr. W. A. Pool, M.R.C.V.S., on reversion from military service, has been appointed Second Bacteriologist, Imperial Bacteriological Laboratory, Muktesar, with effect from the 30th July, 1919.

Mr. G. A. D. Stuart, I.C.S., is granted combined leave for one year with effect from the date of relief of his officiating appointment as Agricultural Adviser to the Government of India.

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Mr. R. H. Ellis, I.C.S., has been appointed to act as Director of Agriculture, Madras, in relief of Mr. R. Cecil Wood, M.A., and until further orders.

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Mr. R. C. Broadfoot, Probationary Deputy Director of Agriculture, Madras, has been appointed to act as Superintendent, Central Farm, Coimbatore.

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Mr. P. H. Rama Reddi, Probationary Deputy Director of Agriculture, Madras, has been appointed on completion of his training to act as Deputy Director, II & III Circles, *vice* Mr. G. R. Hilson granted leave or until further orders.

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Mr. P. C. Patil, L.Ag., who has been appointed to the Indian Agricultural Service, has been confirmed in the appointment of Deputy Director of Agriculture, Northern Division, Bombay, from the 1st March, 1919.

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Mr. Bhimbhai M. Desai has been appointed Deputy Director of Agriculture, Gujarat, with effect from the 1st April, 1919.

***

Mr. D. L. Sahasrabudhe, B.Sc., L.Ag., Assistant Professor of Chemistry at the Agricultural College, Poona, has been appointed to act as Agricultural Chemist to Government, Bombay, with effect from the 1st June, 1919, pending further orders.

***

Mr. G. Taylor, M.R.C.V.S., Superintendent, Civil Veterinary Department, South Punjab, has been appointed to officiate as

Superintendent, Civil Veterinary Department, Bombay, with effect from the 12th July, 1919, *vice* Lieutenant-Colonel G. K. Walker, C.I.E., O.B.E., F.R.C.V.S., appointed to officiate as Principal, Veterinary College, Lahore.

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MR. A. D. MCGREGOR has been appointed to act as Superintendent, Civil Veterinary Department, Bengal.

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MR. RAJESWAR DAS GUPTA, who has been appointed to the Indian Agricultural Service, has been confirmed as Deputy Director of Agriculture, Bengal, from the 1st April, 1919. He has been placed in charge of the Northern Circle, but will continue to act as Deputy Director of Agriculture, Western Circle, in addition to his own duties, during the absence of Mr. F. Smith on leave.

***

MR. N. S. MCGOWAN, B.A., Professor of Agriculture, Agricultural College, Sabour, has been granted combined leave for one year from the 1st April, 1919. Mr. Surendranath Sil, B.A., M.Sc. A., officiates as Professor of Agriculture during Mr. McGowan's absence.

***

MR. T. F. QUIRKE, M.R.C.V.S., Superintendent, Civil Veterinary Department, North Punjab and North-West Frontier Province, has been granted combined leave for six months with effect from 26th May, 1919. Mr. J. S. Garewal, M.R.C.V.S., officiates in Mr. Quirke's place.

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RAI SAHIB LALA KOTU RAM, Deputy Superintendent, Civil Veterinary Department, has been appointed to act as Superintendent, Civil Veterinary Department, South Punjab, *vice* Mr. G. Taylor transferred to Bombay.

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MR. H. E. CROSS, M.R.C.V.S., Civil Veterinary Department, Punjab, has been granted an extension of furlough for eight months.

Mr. F. J. Plymen, A.C.G.I., Deputy Director of Agriculture, has resigned his seat on the Legislative Council of the Chief Commissioner of the Central Provinces.

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Mr. G. Evans, C.I.E., M.A., on the completion of his special duty in Burma, has returned to the Central Provinces.

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Mr. A. G. Birt, B.Sc., Deputy Director of Agriculture, Assam, is allowed combined leave for one year and four months with effect from the 24th June, 1919. Srijut Lakheswar Barthakur, Superintendent of Agriculture, Assam Valley, is appointed to officiate.

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Mr. E. S. Farbrother, M.R.C.V.S., is confirmed in the Civil Veterinary Department and appointed to officiate as Superintendent, Civil Veterinary Department, Sind, Baluchistan and Rajputana, with effect from the 1st July, 1919.

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The seventh annual meeting of the Indian Science Congress will be held at Nagpur from the 12th to the 17th January, 1920.

Sir Benjamin Robertson, K.C.S.I., K.C.M.G., C.I.E., Chief Commissioner of the Central Provinces, has consented to be Patron of the meeting, whilst Sir P. C. Ray, C.I.E., D.Sc., Ph.D., Palit Professor of Chemistry, Calcutta University, will be its President.

The Sectional Presidents will be :—

Applied Botany and Agriculture. Mr. D. Clouston, C.I.E., M.A., B.Sc., Offg. Director of Agriculture, Central Provinces.

Physics and Mathematics. Dr. N. A. F. Moos, F.R.S.E., formerly Director, Bombay and Alibag Observatories.

Chemistry. Mr. B. K. Singh, M.A., F.C.S., Offg. Professor of Chemistry, Government College, Lahore.

Systematic Botany. Mr. P. F. Fyson, B.A., F.L.S., Professor of Botany, Presidency College, Madras.

Zoology. Mr. E. Vredenburg, B.L., B.Sc., A.R.S.M., A.R.C.S., F.G.S., Superintendent, Geological Survey of India.

Geology. Mr. P. Sampatiengar, M.A., F.G.S., Offg. Geologist, Department of Geology and Mines, Mysore.

Medical Research. Lieut.-Col. J. W. Cornwall, M.A., M.D., D.P.H., I.M.S., Director, Southern India Pasteur Institute, Coonoor.

Further particulars of the meeting may be obtained from the Honorary Secretary, Dr. J. L. Simonsen, Forest Research Institute, Dehra Dun.

Reviews

Forecasting the Yield and the Price of Cotton.—By H. L. MOORE. (Macmillan & Co.)

THE United States produces more than one-half of the total world's output of cotton of 30 million bales, but, owing to the organization of the American trade, the price of cotton in every market in the world depends more on the American price than the relative American production alone would indicate. The prediction of the yield and price of American cotton is, therefore, a matter which concerns the whole cotton-buying world. In applying the method of correlation to the problem of the yield of American cotton Professor Moore has been anticipated by Kincer. But Kincer, though he obtained a high value for the correlation, did so by multiplying his rain and temperature variables by more or less arbitrary coefficients, which themselves depend on the antecedent climatic conditions. By choosing a sufficient number of such coefficients any correlation however high can be obtained, and there is no assurance that the formula of prediction is anything more than an empiricism, summing up past events, but of no use in predicting future ones. To this criticism the whole theory of correlation, except where it is used to measure quantitatively the association between known 'veræ causæ,' and their effect is, to some extent, exposed. In using the method of multiple correlation, in particular, long series are necessary if the number of variables used is at all large. Thus Professor Moore uses the rainfall in May, and the mean temperatures of June and August to predict the yield of cotton in Georgia, and obtains a multiple correlation coefficient of 0·732, which suffices to cut down the error of prediction to about 70 per cent. of the error of a pure guess based on the mean outturn. But the series from which the 3 total correlations are obtained is only one of 20 years,

and this somewhat modifies, though it does not entirely vitiate, the value of the formula of prediction. The results obtained for Georgia suggest that high rainfall in May and high temperature in August are harmful to the cotton crop, while in June high temperatures are beneficial. To what extent these are true effects of rainfall and temperature, or merely the result of some allied condition, such as plant disease, which in its turn is dependent on climate, cannot of course be stated off-hand, nor indeed, for a first approximation forecast, does it matter. For the prediction of the price of Upland cotton from the total American output in bales, even higher correlations are obtained. For example, the correlation between the percentage change in price and the percentage in production is found to be $-0{\cdot}819$ and the multiple correlation co-efficient between the price of Upland cotton and the combined factors of total production of cotton and index prices of all commodities is $0{\cdot}859$, from which the error of prediction can be reduced to one-half of the standard deviation of the price of cotton from year to year. It appears, however, to be nowhere stated on what date the price is taken.

Though Professor Moore has obtained some useful results, and has shown conclusively that from climatic conditions the American cotton crop can be forecasted in nearly every case more accurately than the official forecast succeeds in doing, and that often a month earlier, it is impossible to admit that he has obtained a complete solution of the problem of cotton prices, or indeed that such a solution can be found from the mere application of the method of multiple correlation, as Professor Moore appears to imagine (p. 151). That an immense improvement in official crop forecasts can be effected by the method of correlation has been known in India for many years, and it has been shown that some sugarcane forecasts are, like the May American cotton forecasts, worse than useless; but to suppose that a final physical, chemical, physiological and economic phenomenon solution is to be obtained by pure statistics is a misconception, which nevertheless should not blind us to the merits of the methods evolved by Francis Galton and Karl Pearson.

In another respect Professor Moore seems to go above his last in attempting to better the official forecast of cotton based on the

condition-ratio figures issued on the 1st of May, June, July and August. These figures Professor Moore correlates with the corresponding yield-ratios, and finds as was to be expected that the correlation is less than unity. He then constructs the regression equation of yield-ratio on condition-ratio, and offers this as a better prediction formula than the official prediction itself. This is an astonishing perversion of the method of statistics. Fortunately the author only seems to treat this prediction formula as a side issue, but as it has no meaning whatever it should not have been introduced.

To sum up, the book is a definite step on the lines of attack of the problem of forecasts adopted by Hooker, Warren Smith and others. [S. M. J.]

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Farmers' Clean Milk Book—By CHARLES EDWARD NORTH, M.D. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall.) Price 5*s*. net.

THIS book is got up on the popular style. The matter is expressed in non-technical language and will appeal to a very wide circle of readers. Although the advice is useful, nothing fresh is given to dairymen who carry on their work in an up-to-date manner. It may naturally be inferred from the publication of a work of this kind that the health authorities think that there is still much headway to make in producing safe milk in America.

While some information regarding the entry of the disease-producing bacteria into milk is given, and while pasteurization is described in a general way, an important point, namely, the thermal death-point of disease-producing germs and the exposure required at a given temperature to kill them, is omitted. In other words, the temperature of pasteurization and the time for which milk should be kept at that given temperature under different conditions have been passed over. Since the ordinary conditions of practical dairying differ considerably from those in the laboratory, Dr. North might have instructed his readers on points regarding temperature and exposure required to kill the more important pathogenic bacteria.

The importance of the personal element, namely, persons working with milk being cleanly as regards themselves, and also as regards cows and dairy utensils, is a point with which all will agree. Dr. North has demonstrated this by arranging for good dairymen to take over temporarily inefficient dairies and manage such in an up-to-date manner. The results obtained are very striking indeed, and one is surprised that there should be still in America such backward methods in practice.

Apparently in America most milk producers object to the frequent visits of the dairy inspectors, as they add to the cost of producing milk. Such things as up-to-date management of cattle, buildings, pasteurizing, etc., etc., all cost money, and add very considerably to the cost of production. It is here that the health authorities, the producers and the consumers appear to come into conflict. The consumer wants cheap milk, the health authorities demand that milk should be produced on up-to-date lines, thereby adding to the cost of production; while the milk producers insist that the increased rates paid for an up-to-date milk supply are not commensurate with the increased expenditure.

While the book aims at educating the milk producers and dairymen, little has been demonstrated on the lines of educating public opinion on the value of a satisfactory milk supply. Some hints to milk consumers generally would also have proved useful and added to the value of the work.

In the closing chapter, dairy arithmetic is dealt with, and it is there shown that, taking the food item alone, good milking cows produce milk at a lower cost than bad milking cows. The statement, while correct, is very incomplete, as at least 13 other items add their quota to the cost of milk production. Such statements are liable to create in the mind of consumers some suspicions as regards farmers' profits. In cases of this kind, one should like to see the subject of costs either fully dealt with or entirely omitted.

On the whole, the book contains useful information and may be read with advantage. [A. C.]

Correspondence

INTERMITTENT BEARING OF FRUIT TREES.

To The Editor,

The Agricultural Journal of India.

Sir,

In a note published on page 673, Vol. XIV, Part IV, of your journal, and entitled "How to avoid intermittent bearing of fruit trees," there appears a review of an article from "Country Life." The author of the article attributes the non-bearing of certain fruit trees in alternate years to the exhaustion of all reserve material during the years of abundant bearing. He considers that this may be rectified by a liberal supply of easily assimilable manure at the time of the formation of fruit buds for the coming year. In support of this suggestion he cites the regular bearing of espalier trees and trees under glass.

Readers of your valuable journal may be interested to know that the same question with reference to apple trees, is discussed in an illustrated article in the "Journal of Heredity," Vol. IX, No. 7, November 1918. The author, Mr. B. S. Brown, considers this biennial bearing condition to be a "habit" forced on the tree by conditions of environment in the early life-history of the individual. This habit is said to be not inheritable and can largely be corrected by a copious thinning of the fruits during the bearing year to prevent complete exhaustion. There is an interesting illustration of a graft apple tree, half "Gravenstein" and half "Russian," in which the two halves, for some unaccountable reason, have chosen two opposite years for their heavy crop, with the result that in one year one half is loaded with fruits and in the succeeding year the other half.

Yours faithfully,

T. S. Venkataraman,

Ag. Govt. Sugarcane Expert.

Coimbatore:

The 18*th July*, 1919.

NEW BOOKS

ON AGRICULTURE AND ALLIED SUBJECTS

1. Lawson's Text-Book of Botany (Indian edition). Revised and adapted by Birbal Sahni and M. Willis. With a preface by Dr. J. C. Willis. New and revised edition. Pp. xii+610. (London : W. B. Clive, University Tutorial Press.) Price, 8*s.* 6*d.*
2. Botany of the Living Plant, by F. O. Bower. Pp. x+580. (London : Macmillan & Co.) Price, 25*s.* net.
3. The Strawberry in North America—History, Origin, Botany, and Breeding, by Professor S. W. Fletcher. Pp. xiv+234. (London : Macmillan & Co.) Price, 8*s.* net.
4. Practical Physiological Chemistry, by S. W. Cole. With an introduction by Professor F. G. Hopkins. Fifth edition. Pp. xvi+401. (Cambridge : W. Heffer & Sons, Ltd.; London : Simpkin, Marshall, Ltd.) Price, 15*s.* net.
5. Productive Agriculture, by Professor J. H. Gehres. Pp. xii+436. (London : Macmillan & Co.) Price, 5*s.* 6*d.* net.
6. Irrigation Engineering, by Dr. A. P. Davis and H. M. Wilson. Seventh edition. Pp. xxiii+640. (New York : J. Wiley & Sons, Inc. ; London : Chapman & Hall.) Price, 21*s.* net.
7. Practical Butter-making, by C. W. Walker-Tisdale and T. R. Robinson. Fourth revision. Pp. 143. (London : Headley Bros.) Price, 5*s.* 6*d.* net.
8. The Preparation of Substances important in Agriculture, by Prof. C. A. Peters. Third edition. Pp. vii+81. (New York : J. Wiley & Sons, Inc.; London : Chapman & Hall.) Price, 4*s.* net.

9. An Introduction to the Study of Biological Chemistry, by S. B. Schryver, D.Sc. Modern Outlook Series. Pp. 340. (London : J. C. and E. C. Jack.) Price, 6*s*. net.

10. Co-operation in Danish Agriculture, by Harold Faber, an English adaptation of *Andelsbevaegelsen i Denmark*, by H. Hartel, with a foreword by E. J. Russell. Pp. xxii+176. (London : Longmans Green & Co.) Price, 8*s*. 6*d*. net.

11. The Modern Milk Problem in Sanitation, Economics, and Agriculture, by J. S. MacNutt. Pp. xi+258+xvi plates. (London : Macmillan & Co.) Price, 10*s*. 6*d*. net.

12. Peach-growing, by H. P. Gould. Pp. xxi+426+xxxii plates. (London : Macmillan & Co.) Price, 10*s*. 6*d*. net.

13. Elementary Chemistry of Agriculture, by S. A. Woodhead. Pp. 188. (London : Macmillan & Co.)

14. Hints to Farm Pupils, by E. W. Lloyd. Pp. 112. (London : John Murray.) Price, 2*s*. 6*d*. net.

15. Co-operation for Farmers, by L. Smith Gordon. Pp. 247. (London : Williams & Norgate.) Price, 6*s*. net.

THE following publications have been issued by the Imperial Department of Agriculture in India since our last issue :—

Memoirs.

1. Studies in Indian Sugarcanes, No. 4. Tillering or underground branching, by C. A. Barber, C.I.E., Sc.D., F.L.S. (Botanical Series, Vol. X, No. 2.) Price, Rs. 4-4 or 7*s*.

2. Studies in Indian Sugarcanes, No. 5. On testing the suitability of sugarcane varieties for different localities, by a system of measurements. Periodicity in the growth of the sugarcane, by C. A. Barber, C.I.E., Sc.D. F.L.S. (Botanical Series, Vol. X, No. 3.) Price, R. 1-12 or 3*s*.

3. The Phosphate Requirements of some Lower Burma Paddy Soils, by F. J. Warth, M.Sc., B.Sc.; and Maung Po Shin. (Chemical Series, Vol. V, No. 5.) Price, R. 1-12 or 3*s*. 3*d*

Bulletins.

1. Cawnpore-American Cotton : An Account of Experiments in its Improvement by Pure Line Selection and of Field Trials, 1913–1917, by B. C. Burt, B.Sc., and Nizamuddin Haider. (Bulletin No. 88.) Price, As. 10 or 1*s.*
2. Resham-shilper unnatikalpé tuntbhook resham keetjáti sambandhe parikshar dwitiya bibaranee, by M. N. De. (Bengalee version of Pusa Bulletin No. 74 on "Second Report on the Experiments carried out at Pusa to Improve the Mulberry Silk Industry.") Price, As. 12 or 1*s.*

Reports.

1. Proceedings of the Second Meeting of Mycological Workers in India, held at Pusa on the 20th February, 1919, and following days. Price, As. 11 or 1*s.*
2. Proceedings of the First Meeting of Veterinary Officers in India, held at Lahore on the 24th March, 1919, and following days (with Appendices). Price, As. 8 or 9*d.*

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM 1ST FEBRUARY TO 31ST JULY, 1919.

No.	Title	Author	Where published
	GENERAL AGRICULTURE		
1	The *Agricultural Journal of India*, Vol. XIV, Parts II & IV. Price Rs. 2 or 3*s.*; annual subscription, Rs. 6 or 8*s.* 6*d.*	Edited by the Agricultural Adviser to the Government of India.	Messrs. Thacker, Spink & Co., Calcutta.
2	Special Indian Science Congress Number (1919) of the Agricultural Journal of India, Vol. XIV, Part III. Price Rs. 2 or 3*s.*	Ditto	Ditto.
3	Progress of the sugarcane industry in India during the years 1916 and 1917. Being notes submitted to the meeting of the Board of Agriculture in India, Poona, 1917. Pusa Agricultural Research Institute Bulletin No. 83. Price As. 5 or 6*d.*	Edited, with an introduction, by C. A. Barber, C.I.E., SC.D., F.L.S., Chairman of the Sugar Committee of the Board of Agriculture in India, 1917.	Government Printing India, Calcutta.
4	Cawnpore-American cotton: An account of experiments in its improvement by pure line selection and of field trials, 1913-1917. Pusa Agricultural Research Institute Bulletin No. 88. Price As. 10 or 1*s.*	B. C. Burt, B.SC., Deputy Director of Agriculture, Central Circle, United Provinces, Cawnpore; and Nizamuddin Haider, Subordinate Agricultural Service, United Provinces.	Ditto.
5	Annual Report of the Board of Scientific Advice for India for the year 1917-18. Price As. 14 or 1*s.* 3*d.*	Issued by the Board of Scientific Advice for India.	Ditto.
6	Agricultural Statistics of India, 1916-17, Vol. I. Price Rs. 2 or 3*s.* 6*d.*	Issued by the Department of Statistics, India.	Ditto.
7	Agricultural Statistics of India, 1916-17, Vol. II. Price R. 1.	Ditto ..	Ditto.
8	Agricultural Statistics of British India, 1917-18. Price As. 4 or 5*d.*	Ditto ..	Ditto

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
9	Agricultural Statistics of Bengal for 1917-18. Price R. 1-8 or 2*s.* 3*d.*	Issued by the Government of Bengal, Revenue Department.	Bengal Secretariat Book Depôt, Calcutta.
10	Season and Crop Report of Bengal for 1918-19. Price R. 1-5.	Issued by the Department of Agriculture, Bengal.	Ditto.
11	Rules for the organization of Village Agricultural Associations (English).	Ditto ..	Ditto.
12	Departmental Records: Some suggestions as to the organization of agricultural exhibition in Bengal (Reprinted) (for official use only).	E. J. Woodhouse, Economic Botanist, Bengal.	Ditto.
13	Season and Crop Report of Bihar and Orissa for 1918-19. Price R. 1 or 1*s.* 4*d.*	Issued by the Department of Agriculture, Bihar and Orissa.	Bihar and Orissa Government Press, Patna.
14	Agricultural Statistics of Bihar and Orissa for 1917-18. Price As. 12 or 1*s.*	Ditto ..	Ditto.
15	Notes on improved methods of cane cultivation. United Provinces Department of Agriculture Bulletin No. 35 (Revised).	G. Clarke, F.I.C., Agricultural Chemist, United Provinces, and Naib Hussain.	Government Press, United Provinces, Allahabad.
16	Report on the Lawrence Gardens, Lahore, for 1918-19. Price As. 2 or 2*d.*	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
17	Annual Report of the Department of Agriculture, Bombay, for 1917-18. As. 12 or 1*s.* 2*d.*	Issued by the Department of Agriculture, Bombay.	Yeravda Prison Press, Poona.
18	First Report on Fruit culture as practised round about Tharushah (Sind) in Nawabshah District. Bombay Dept. of Agriculture Bulletin No. 88 of 1918. Price As. 2 or 2*d*	Mahamed Umar Khan F. Barakyai, D. Ag., Agricultural Department, Sind.	Ditto.
19	Artificial manures: Experiments on their value for crops in Western India, No. II. Bombay Department of Agriculture Bulletin No. 89 of 1918. Price As. 3-3p. or 4*d.*	Harold H. Mann, D.Sc., Principal, Poona Agricultural College, and S. R. Paranjpe, B.Ag.	Ditto.
20	The cultivation of Cape gooseberry or *Tiparee.* Bombay Department of Agriculture Leaflet No. 9 of 1918.	Issued by the Department of Agriculture, Bombay.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
21	Plantain stalks as fodder for cattle in famine years. Bombay Department of Agriculture Leaflet No. 1 of 1919.	Issued by the Department of Agriculture, Bombay.	Yeravda Prison Press, Poona.
22	Exhibit of food and industrial products made from local agricultural produce at the Madras Industrial Exhibition, December 1917. Madras Department of Agriculture Bulletin No. 76.	Rao Sahib M. R. Ramaswami Sivan, B.A., Assistant Agricultural Chemist, Agricultural College, Coimbatore.	Government Press, Madras.
23	Note on simple machines for extracting plantain fibre. Madras Department of Agriculture Bulletin No. 77 (Revised edition of Bull. No. 47).	R. L. Proudlock ..	Ditto.
24	Graft mangoes: how to start and maintain a mango garden. Madras Department of Agriculture Leaflet No. 6 of 1918.	D. Balkrishna Murthi Garu, Acting Deputy Director of Agriculture, Madras.	Ditto.
25	Report on demonstration work in the Southern Circle, Central Provinces, for 1917-18. Price As. 8.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
26	Report on Agricultural Stations in the Southern Circle, Central Provinces, for 1917-18. Price As. 8.	Ditto ..	Ditto.
27	Rice selection in Chhattisgarh. Price As. 2.	Ditto ..	Ditto.
28	Self-help in Agriculture. Price As. 2.	Ditto ..	Ditto.
29	The *Agricultural and Co-operative Gazette* (monthly) from February to July 1919. Price As. 2 per copy.	Ditto ..	Shalom Press, Nagpur.
30	Report of the Agricultural Department, Assam, for the period from 1st July 1918, to the 31st March 1919. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
31	Report on the Season and Crops of Assam for 1918-19. Price As. 8 or 9*d*.	Ditto ..	Ditto.
32	Report of the Fruit Experiment Station, Shillong, for nine months ending 31st March, 1919.	Ditto ..	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
33	Report of the Kamrup Sugarcane Experiment Station for nine months ending 31st March, 1919.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
34	Report of the Jorhat Agricultural Experiment Station for nine months ending 31st March, 1919.	Ditto ..	Ditto.
35	Report of the Karimganj Agricultural Experiment Station for nine months ending 31st March, 1919.	Ditto ..	Ditto.
36	Report of the Upper Shillong Agricultural Experiment Station for nine months ending 31st March, 1919.	Ditto ..	Ditto.
37	Season and Crop Report of Burma for 1918-19. Price R. 1 or 1*s.* 6*d.*	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
38	Report on the operations of the Department of Agriculture, Burma, for 1917-18. Price As. 8 or 9*d.*	Ditto ..	Ditto.
39	Annual Reports of the Agricultural Stations, the Assistant Botanist of the Northern Circle, the Assistant Entomologist and the Agricultural Chemist to the Government of Burma for 1917-18.	Ditto ..	Ditto.
40	Proceedings of an Agricultural Conference held in Maymyo on the 20th May, 1919.	Ditto ..	Ditto.
41	Proceedings of a Conference between Superintendents, Northern and Southern Shan States, and the Departments of Irrigation, Co-operative Credit and Agriculture held at Maymyo on the 18th, 19th, 20th, 23rd and 24th May, 1919.	Ditto ..	Ditto.
42	Cultivators' Leaflet on potato cultivation in Kachin (Romanised character).	Ditto ..	Ditto.
43	Improvements in the packing and transport of fruit in India. Quetta Fruit Experiment Station Bulletin No. 2. (Third Edition.)	Albert Howard, C.I.E., M.A., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Second Imperial Economic Botanist.	Baptist Mission Press, Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—concld.		
44	The saving of irrigation water in wheat growing. Quetta Fruit Experiment Station Bulletin No. 4. (Second Edition.)	Albert Howard, C.I.E., M.A., Imperial Economic Botanist, and Gabrielle L.C. Howard, M.A., Second Imperial Economic Botanist.	Baptist Mission Press, Calcutta.
45	Report on the operations of the Department of Agriculture and Fisheries, Travancore, for 1917-18.	Issued by the Department of Agriculture and Fisheries, Travancore.	Government Press, Trivandrum.
46	Annual Report of the Agricultural Department, Gwalior Government, for 1917-18.	Issued by the Department of Agriculture, Gwalior.	Alijah Darbar Press, Lashkar.
47	The *Journal of the Madras Agricultural Students' Union* (monthly). Annual subscription, Rs. 2.	Madras Agricultural Students' Union.	Literary Sun Press, Coimbatore.
48	*Quarterly Journal of the Indian Tea Association.* Price As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Press, Calcutta.
49	The *Journal of Dairying and Dairy-Farming in India* (quarterly). Subscription Rs. 5 per annum (including membership).	Published by the Indian Committee of the Dairy Education Association, Quetta.	Messrs. Thacker, Spink & Co., Calcutta.
50	*Poona Agricultural College Magazine* (quarterly). Annual subscription, Rs. 2.	College Magazine Committee, Poona.	Arya Bhusan Press, Poona.
51	*Journal of the Mysore Agricultural and Experimental Union* (quarterly). Annual subscription, Rs. 3.	Mysore Agricultural Experimental Union.	Bangalore Press, Bangalore.
	AGRICULTURAL CHEMISTRY		
52	An improved method of preparing indican from indigo-yielding plants. Pusa Indigo Publication No. 5. Price As. 2 or 3*d*.	Bhailal M. Amin, B.A., First Assistant to the Indigo Research Chemist, Pusa.	Government Printing, India, Calcutta.
	BOTANY		
53	Studies in Indian Sugarcanes, No. 4. Tillering or underground branching. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. X, No. 2. Price Rs. 4-4 or 7*s*.	C. A. Barber, C.I.E., SC.D., F.L.S., Government Sugarcane Expert, Madras.	Messrs. Thacker, Spink & Co., Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*concld.*

No.	Title	Author	Where published
	ENTOMOLOGY		
54	Resham shilper unnatikalpe tuntbhook Resham keetjati sambandhé Parikshár dwitiya bibaranee (Bengalee version of Pusa Agricultural Research Institute Bulletin No. 74). Price As. 12 or 1*s*.	M. N. De, Sericultural Assistant, Pusa.	Baptist Mission Press, Calcutta.
	VETERINARY		
55	Are camels susceptible to Black Quarter, Hæmorrhagic Septicæmia and Rinderpest? Pusa Agricultural Research Institute Bulletin No. 80. Price As. 4 or 5*d*.	H. E. Cross, M.R.C.V.S., D.V.H., A.Sc., Camel Specialist to Government, Sohawa, Punjab.	Government Printing, India, Calcutta.
56	A new nematode causing parasitic gastritis in calves. Pusa Agricultural Research Institute Bulletin No. 86. Price As. 4 or 5*d*.	A. L. Sheather, B.Sc., M.R.C.V.S., Director and First Bacteriologist, Imperial Bacteriological Laboratory, Muktesar.	Ditto.
57	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for 1918-19.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
58	Annual Report of the Civil Veterinary Department, United Provinces, for 1918-19	Issued by the Civil Veterinary Department, United Provinces.	Government Press, United Provinces, Allahabad.
59	The branding, flaying and curing of hides. Burma Department of Agriculture Cultivators' Leaflet No. 51.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
60	Household Dairying (in Marathi).	B. K. Ghare, L.Ag., Lecturer, Agricultural College, Cawnpore.	Arya Bhusan Press, Poona.
61	Statistics compiled by the Government of India from the Reports of Provincial Civil Veterinary Departments for the year 1917-18.	Issued by the Revenue and Agriculture Department of the Government of India.	Government Monotype Press, Simla.

PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

TO BE HAD FROM

THE OFFICE OF THE AGRICULTURAL ADVISER TO THE GOVERNMENT OF INDIA, PUSA, BIHAR, *and from the following Agents :—*

(1) THACKER, SPINK & CO., CALCUTTA.
(2) W. NEWMAN & CO., CALCUTTA.
(3) RAI M. C. SARKAR BAHADUR & SONS, CALCUTTA.
(4) HIGGINBOTHAMS, LTD., MADRAS.
(5) THOMPSON & CO., MADRAS.
(6) D. B. TARAPOREVALA, SONS & CO., BOMBAY.
(7) THACKER & CO., LTD., BOMBAY.
(8) SUNDER PANDURANG, BOMBAY.
(9) RAI SAHIB M. GULAB SINGH & SONS, LAHORE.
(10) MANAGER, EDUCATIONAL BOOK DEPOT, NAGPUR.

A complete list of the publications of the Imperial Department of Agriculture in India can be obtained on application from the Agricultural Adviser to the Government of India, Pusa, Bihar, or from any of the above-mentioned Agents.

These publications are :—

1. The *Agricultural Journal of India*. A Quarterly Journal dealing with subjects connected with agricultural economics, field and garden crops, economic plants and fruits, soils, manures, methods of cultivation, irrigation, climatic conditions, insect pests, fungus diseases, co-operative credit, agricultural cattle, farm implements, and other agricultural matters in India. Illustrations, including coloured plates, form a prominent feature of the Journal. It is edited by the Agricultural Adviser to the Government of India. *Annual Subscription*, Rs. 6 or 8*s*. 6*d*., including postage. Single copy, Rs. 2 or 3*s*.
2. Scientific Reports of the Agricultural Research Institute, Pusa (including the Report of the Imperial Cotton Specialist).
3. Annual Report on the Progress of Agriculture in India.
4. Proceedings of the Board of Agriculture in India.
5. Proceedings of Sectional Meetings of the Board of Agriculture.
6. Memoirs of the Imperial Department of Agriculture in India :
   (a) Botanical Series.
   (b) Chemical Series.
   (c) Entomological Series.
   (d) Bacteriological Series.
   (e) Veterinary Series.
7. Bulletins issued by the Agricultural Research Institute, Pusa.
8. Books.

The following are the publications of the last two years :—

Scientific Reports of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for the year 1916-17. Price, As. 9 or 10*d*.

Scientific Reports of the Agricultural Research Institute, Pusa (including the Report of the Imperial Cotton Specialist), for the year 1917-18. Price, R. 1-4 or 2*s.*

Report on the Progress of Agriculture in India for the year 1916-17. Price, As. 12 or 1*s.* 1*d.*

Report on the Progress of Agriculture in India for the year 1917-18. Price, R. 1-8 or 2*s.* 3*d.*

Proceedings of the Board of Agriculture in India, held at Poona on the 10th December, 1917, and following days (with Appendices). Price, As. 13 or 1*s.* 3*d.*

Proceedings of the Second Meeting of Mycological Workers in India, held at Pusa on the 20th February, 1919, and following days. As. 11 or 1*s.*

Proceedings of the First Meeting of Veterinary Officers in India, held at Lahore on the 24th March, 1919, and following days (with Appendices). As. 8 or 9*d.*

MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA

BOTANICAL SERIES

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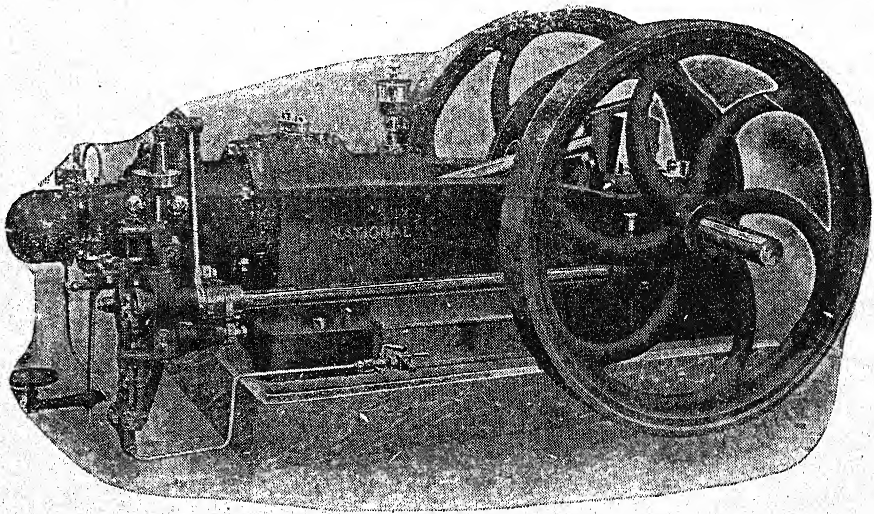

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